A. M. A.

ARCHIVES OF

OPHTHALMOLOGY

Continuing the Publication
FOUNDED BY HERMAN KNAPP, 1869

EDITORIAL BOARD

FRANCIS HEED ADLER, Chief Editor
313 South Seventeenth Street, Philadelphia 3

WILLIAM ZENTMAYER, Philadelphia
W. L. BENEDICT, Rochester, Minn.
KENNETH C. SWAN, Portland, Ore.
WILLIAM F. HUGHES Jr., Chicago
DAVID G. COGAN, Boston
JONAS S. FRIEDENWALD, Baltimore
JOHN H. DUNNINGTON, New York

RICHARD J. PLUNKETT, M.D., Chicago, Managing Editor

ASSOCIATES:

James H. Allen
John G. Bellows
Milton L. Berliner
Hermann M. Burian
F. Bruce Fralick
Michael J. Hogan
Everett Kinsey
Irving H. Leopold
A. E. Maumenee
Kenneth Ogle
C. Wilbur Rucker
Harold G. Scheie

JANUARY 1951
VOLUME 45 NUMBER 1

Published Monthly by
AMERICAN MEDICAL ASSOCIATION
535 NORTH DEARBORN STREET • CHICAGO 10, ILLINOIS

Entered as Second Class Matter Feb. 7, 1929, at the Postoffice at Chicago, Under the Act of March 3, 1879. Annual Subscription, $12.00

THE MAKING AND FITTING OF ARTIFICIAL EYES ARE A SPECIALTY WITH US

Not a Sideline!

Experience gained through over 100 years of artificial eyemaking enables us to produce and fit the very finest in eyes of glass and plastic.

- **24 hour mail order selection service for glass and plastic stock eyes.**
- **Our eyemakers and technicians travel to most principal cities.**
- **Our technicians are especially trained to fit artificial eyes to all types of motility implants.**

TROUTMAN INTEGRATED MAGNETIC IMPLANT

Developed by R. C. Troutman, M.D.

Integration of the Troutman magnetic implant is accomplished without the use of a pin attachment for direct transmission of motility, but through the use of a magnetic field which is created between the implant and the prosthesis by the use of magnets in both. This allows *complete coverage* of the implant by *Tenon's and the conjunctiva* and still maintains positive integration.

Description and surgical technique is available upon request.

Color films showing surgical technique will be loaned to clinical groups upon request.

100 YEARS OF ARTIFICIAL EYEMAKING

CHICAGO
DETROIT
CLEVELAND
KANSAS CITY
MINNEAPOLIS
NEW ORLEANS
ST. LOUIS

MAGER & GOUGELMAN, INC.

Paul Gougelman Company

30 NORTH MICHIGAN AVENUE · CHICAGO, ILLINOIS

NEW YORK
BALTIMORE
BOSTON
BUFFALO
PHILADELPHIA
PITTSBURGH
WASHINGTON

A SCIENTIFIC CORNER

WHERE OPTICAL PROBLEMS ARE DISCUSSED AND
THE SOLUTIONS, AS SOLVED BY EXPERIENCE, INDICATED!

PRESENTED BY

THE HOUSE OF VISION

BELGARD-SPERO, INC.

CHICAGO

EVANSTON OAK PARK MILWAUKEE AURORA MUSKEGON

MINNEAPOLIS HIGHLAND PARK DES MOINES MASON CITY

CALCULATING VERTEX CHANGES

The mathematics of vertex changes are simple. They are based on the fact that a 1.00 D lens has a focal length of 1,000 mm. Therefore, a 2.00 D lens would have a focal length of 500 mm.; a 10.00 D lens, 100 mm.; a 5.00 D lens, 200 mm., and so on. The formulae are $F = \frac{1,000}{D}$ and $D = \frac{1,000}{F}$ in which "D" is the dioptric value of the lens and "F" is the focal length.

Suppose a + 13.00 D lens to be fixed in a trial frame at 17½ mm. from the cornea. Suppose also that the permanent (spectacle) lens was to be 12 mm. from the cornea. A + 13.00 lens has a focal length of 76.9 mm. and since we are moving the + 13.00 lens 5½ mm. nearer the cornea, the permanent lens must have a focal length of 76.9 mm. minus 5.5 mm. or 71.4 mm. 1,000 divided by 71.4 equals + 14.00 (app.) or the strength of the spectacle lens. If the lens was minus instead of plus, we would *add* 76.9 to 5.5 which is 82.4 mm., the focal length of the spectacle lens.

The chart below shows the amount of change, in diopters, of lenses from 5.00 D to 18.00 D when the vertex distance is changed. The chart works as follows: for plus lenses *add* the amount, in diopters, found in the proper column; for minus lenses *subtract* that amount.

For example: A + 11.00 D trial lens moved 4 mm. nearer the eye requires a + 11.50 spectacle lens. A — 11.00 D trial lens moved the same amount requires a — 10.50 spectacle lens.

In computing compounds both meridians must be figured. A + 11.00 + 4.00 cx 180 moved 4 mm. nearer the eye would work out as follows: the + 11.00 sphere becomes a + 11.50 sphere. The cylinder is added to the sphere, in this case + 11.00 + 4.00 or + 15.00, and from the chart shows up as + 15.96. Thus the 180th meridian must be + 11.50 and the 90th meridian + 15.96. To get the new cylinder subtract + 11.50 from + 15.96 which is 4.46 (written 4.50) or the amount of the cylinder. The Rx is written + 11.50 + 4.50 Cx 180.

	DISTANCE NEARER EYE				
Lens Power	1 MM	2 MM	3 MM	4 MM	5 MM
5.00	.02	.05	.07	.10	.12
6.00	.03	.07	.11	.15	.18
7.00	.05	.10	.15	.20	.25
8.00	.06	.13	.19	.26	.33
9.00	.08	.16	.25	.33	.42
10.00	.10	.21	.31	.42	.53
11.00	.12	.24	.37	.50	.64
12.00	.15	.30	.45	.61	.77
13.00	.17	.35	.53	.72	.91
14.00	.20	.41	.62	.84	1.06
15.00	.23	.46	.71	.96	1.22
16.00	.26	.53	.81	1.10	1.40
17.00	.29	.60	.91	1.24	1.58
18.00	.33	.67	1.03	1.47	1.79

"IF IT'S A LENS PROBLEM, LET'S LOOK AT IT TOGETHER"

Sklar's improved model
SCHIOTZ TONOMETER

EACH INSTRUMENT TESTED AND CERTIFIED BY ELECTRICAL TESTING LABORATORIES, Inc., New York City

The improved Sklar-Schiotz Tonometer is made to meet the specifications adopted by the Committee on Standardization of Tonometers of the American Academy of Ophthalmology and Otolaryngology.

All parts, except the frame of this new model instrument, are made of non-magnetic stainless steel. The moving parts are accurately machined, highly polished and fitted to close tolerances in weight and balance to minimize friction. The instrument is made to conform with the basic requirements of the original Tonometer described in 1905 by Professor Hjalmar Schiotz, and modified by him in 1925.

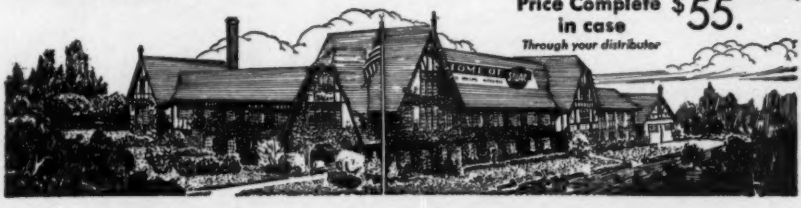
There are two major improvements in this newly designed model by Sklar. They are: (A) the new shape of the hammer and its contact with the plunger, and (B) the new design of the dial with inserted mirror to overcome parallax.

The new model instrument is guaranteed to be serviceable, dependable and accurate for use by the profession.

Complete detailed directions for use, with Table of Intra-Ocular Pressures and Graphs, included with each instrument.

Sklar LONG ISLAND CITY, N.Y.

Price Complete in case $55.
Through your distributor



a definitive reference in the field of ophthalmic surgery...

Surgery of Cataract

by **Daniel B. Kirby, A.M., M.D., LL.D. (Hon.)** *Professor of Ophthalmology, College of Medicine, New York University; Attending Surgeon, Department of Ophthalmology, Bellevue Hospital; Surgeon, New York Eye & Ear Infirmary; Consulting Ophthalmic Surgeon, Manhattan Eye, Ear & Throat Hospital; St. Clare's Hospital, Department of Ophthalmology; New Rochelle Hospital, Department of Ophthalmology*

One of the most exhaustive studies ever made in the field of eye surgery, written by a well-qualified authority. This book covers cataract surgery from the point of view of basic principles, sound technics and procedures. The text synthesizes the most important contributions by others, in addition to Dr. Kirby's own operative developments. Among the many items of clinical information summarized are indications and contraindications for surgery, and the author's method for intracapsular cataract extraction. The various types of cataracts and methods of examining the eye are described, and detailed consideration is given to the problem of prognosis for vision restoration.

Worthy of special mention are the magnificent illustrations, including 52 subjects in color on 21 plates.

This work may well take its place among the truly great source books in surgical literature.

1st Edition, 1950
339 Figures
52 Subjects on 21 Color Plates
695 Pages
$30.00

J. B. LIPPINCOTT COMPANY, East Washington Square, Philadelphia 5, Pa.
Please send me: ☐ Kirby, SURGERY OF CATARACT—$30.00

Name_____

Street_____ ☐ Charge my account

City, Zone, State_____ ☐ Cash enclosed

Lippincott Books

Philadelphia • London • Montreal

never before . . . such FLEXIBILITY

THE

MANOFLEX

FRAME FOR MEN

Zylo Ware announces with pride the new MANOFLEX frame for men — with a temple so perfectly flexible you can mould it on the spot for unsurpassed fit and comfort! A mere twist does it!

You can prescribe MANOFLEX with confidence. It gives a soft, comfortable feeling at the ears. It offers exact moulding to the ear. It assures you that correct positioning at the nose will be maintained. And it's priced for solid economy.

Consult your supplier today.

MANOFLEX TEMPLE CAN BE SUPPLIED ON THE STALWART FRAME.

ZYLO WARE

Zylo Ware Corporation, 11-15 47th Ave., Long Island City 1, N.Y.

Announcing

Better VISION
Better VALUES

BAUSCH & LOMB

Orthogon ST-20
Orthogon ST-22

ORTHOGON IS THE COMPLETE SERIES OF BIFOCAL TYPES

ORTHOGON A
ORTHOGON AA
ORTHOGON B
ORTHOGON C
ORTHOGON D
ORTHOGON F
ORTHOGON ST-20
ORTHOGON ST-22
ORTHOGON PANOPTIK
ORTHOGON PANOPTIK TRIFOCAL
ORTHOGON PANOPTIK LARGE SEG
ORTHOGON PANOPTIK MINUS ADD
ORTHOGON PANOPTIK DOUBLE SEG
ORTHOGON PANOPTIK PRISM SEG
ORTHOGON PANOPTIK MINUS LENTICULAR
ORTHOGON PANOPTIK LENTICULAR CATARACT

Two new "Straight-Top" Bifocals of superior design, construction and performance

With pride, Bausch & Lomb announces two new members of the family of Bausch & Lomb Orthogon bifocals—the world's largest and most distinguished family of bifocal lenses. Orthogon ST-20 (with 20mm segment) and Orthogon ST-22 (with 22mm segment) are of Bausch & Lomb design and Bausch & Lomb construction. They offer superiorities of performance—*Better Vision* and *Better Value*—to users of "straight-top" bifocals.

ORTHOGON CURVES. Orthogon ST-20 and Orthogon ST-22 bifocal lenses are made on Bausch & Lomb Orthogon base curves. This is the system of lens correction based on the principle that only through reduction of astigmatic variation can utmost clarity of vision be achieved.

PROVED COLOR CORRECTION. Glass for Orthogon ST bifocals is the same combination as used in Panoptik—it provides the same *proved* excellence of color correction and stability.

LARGE SQUARE BLANKS

All Orthogon ST blanks are of the new Bausch & Lomb *"Square"* shape, 54mm x 54mm (60mm diagonal)—with segments inset 2mm. This shape provides great flexibility for modern large lens sizes and shapes.

IN SOFT-LITE, TOO. Like all lenses of the Orthogon Series, Orthogon ST-20 and Orthogon ST-22 are available in Soft-Lite, the finest neutral absorption.

BAUSCH & LOMB
OPTICAL COMPANY ROCHESTER 2, N.Y.

IMMEDIATE DELIVERY!

NEW EQUIPMENT

A. O. Deluxe Refracting Unit with Phoroptor-Mahogany — A. O. Stereo-Orthoptor
A. O. Phorometers on Stand or Chair Bracket
A. O. Projecto Charts — A. O. Lensometers
TABLE & FLOOR MODELS
A. O. Giantscope
B. & L. Deluxe Unit with Greens Refractor-Ivory — Plastic & Glass Prisms B. & L.
Adjustable Tables—on Casters — B. & L. New Acuity Projector
B. & L. Morton Ophthalmoscope — Tangent Field Equipment
B. & L. Poser and Universal Slit Lamps — B. & L. Vertometer
B. & L. Keratometer — B. & L. Ortholite

DEPTH PERCEPTION APPARATUS

Castroviejo Retinal Detachment Unit — Perimeter A. O. & B. & L.
A. O. & B. & L. Test Lens Sets — Copeland Streak Retinoscopes
Trial Frame — Red Glass — Holmgren's Color Test 1370
Maddox Rod — Risley Rotary Prisms

PROMPT DELIVERY ON ALL

OPHTHALMOLOGICAL EQUIPMENT • FURNITURE • INSTRUMENTS

INQUIRIES AND ORDERS INVITED BY

S. G. KREBS CO.

AGENTS FOR BAUSCH & LOMB CO. · AMERICAN OPTICAL CO. · SHURON CO. · NATL. ELECTRIC CO. · WELCH ALLYN

351 Second Ave., New York 10, N. Y. — GRamercy 5-0585

WE EXPORT TO ALL PARTS OF THE WORLD

Rx

QUALITY SERVICE

Technical skills and services that will never let you down

DOW

INSURANCE...

It isn't wise to neglect to insure one's house against fire or to carry sufficient life insurance. And it is equally foolish to leave your priceless reputation unprotected against harmful misunderstanding. Poor workmanship and poor materials in the handling of your prescription could easily redound to your discredit.

To send your patients to Dow is tantamount to taking out a gilt-edge insurance policy against these dangers. Our skilled craftsmen (backed by 31 years of knowing how) will interpret your prescription unerringly as you have decreed. You can feel secure in the knowledge that your professional requirements are carried out to the letter . . . as a safeguard for your high standards . . . and as assurance for your patients' comfort.

DOW OPTICAL CO.

W. E. DOW, Pres.

Chicago, Ill. — Bloomington, Ill.

CONDENSED CHAPTERS FROM

The History of the Guild

"GUILDCRAFT"—FOR YOU

It was in the Guild's third year, 1928, that it began the publication of its magazine GUILDCRAFT.

Its purpose has been to provide a common meeting ground where the physician and dispenser might discuss common problems arising out of the close relationship between the two.

During the years, many names distinguished in Ophthalmology and dispensing have appeared as contributors of articles in GUILDCRAFT.

It has now been decided to send GUILDCRAFT to *every* Eye Physician in the United States and Canada, and a whole year has been given to revising the mailing list for this purpose.

But lists are not infallible; nor are we. In the process we have probably missed some names. If *you* have not received a copy of GUILDCRAFT within this last month, won't you send us your name and address so that you may receive it regularly every month hereafter?

No charge, of course! And we think you will like the magazine and find it helpful. It does not seek merely to duplicate the information already published in your own professional literature, but to provide additional information that usually is not otherwise available.

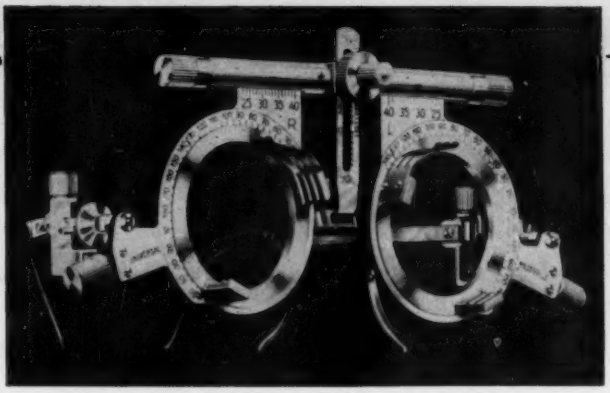
Just drop a penny post card to us, at the address below.

The Guild of Prescription Opticians of America, Inc.

110 E. 23rd Street New York (10) N.Y.

storz
Surgical Instruments

Trial Frame



DURALUMIN FOR LIGHTNESS

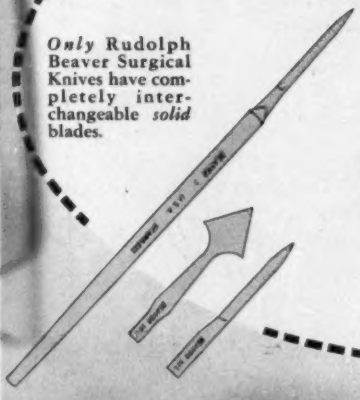
No. 860—This test lens frame permits the use of Tillyer trial lenses by inserting spheres in back, cylinders next, prisms in front. It has independent eye adjustment, accurate temple adjustment, a wide range of positions for the bridge, and a corneal distance gauge. It is strongly constructed but weighs only two ounces.
$42.50

Storz Instrument Co. 4570 Audubon Ave. St. Louis 10, Mo.

BEAVER BLADE
RESORGAM

EYE KNIVES
With Beaver Replaceable Blades
Insure Absolute Uniformity

Only Rudolph Beaver Surgical Knives have completely interchangeable *solid* blades.



Precision-ground Beaver Eye Blades never vary in thickness, shape or efficiency. And, like all other Beaver Blades, they are completely interchangeable — every blade fits every handle. They seat securely — will not weave in an incision. Individually packaged in window-type boxes, they are easy to stock and select.

Made and guaranteed by
Rudolph Beaver Co., Waltham 54, Mass.

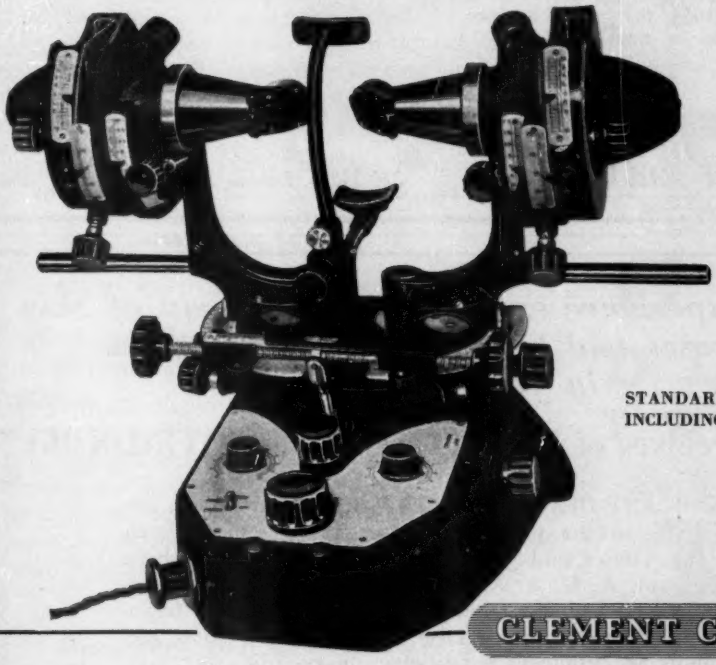
SURGICAL KNIVES BY
Rudolph
Beaver

Ask your dealer or write direct.

PROGRESS

FROM CLEMENT CLARKE LONDON

1838	Wheatstone Stereoscope
1903	Worth's Amblyoscope
1913	Ettles Synoptophore
1939	Moorfields Synoptophore
1950	**LYLE MAJOR AMBLYOSCOPE**



STANDARD INSTRUMENT
INCLUDING TRANSFORMER

CLEMENT CLARKE

16, WIGMORE STREET, LONDON, W.1., ENGLAND

Cablegrams: Clemclarke, London. Telephone: Langham 2242

IN ASSOCIATION WITH ALLIED INSTRUMENT MANUFACTURERS LTD., OF LONDON

★ *Some of the instruments in the Clement Clarke range:*

NEW PROJECTION PERIMETER
NEW PATTERN SLIT LAMP
PRACTITIONER'S CHEIROSCOPE AND HOME MODEL CHEIROSCOPE
VARIABLE PRISM STEREOSCOPE
NEW MADDOX HANDFRAME
MADDOX WING TEST
REMY SEPARATOR
PIGEON CANTONNET STEREOSCOPE
WORTH 4-DOT TEST
DUOCHROME LETTER TEST
FOVEOSCOPE
AIMARK OPHTHALMOSCOPE
ISHIHARA COLOUR TEST
NEW HAND OPERATING LAMP

GUILD OPTICIANS

THE NEW *Harrington*

Erisophake---

Inset of Cup is Actual Size

Surgeons seem to prefer the slightly tapered, pencil-like hand piece of this Harrington erisophake, with its cut-outs for facile control of the vacuum. The instrument makes use of a modified, shallow Dimitry type cup to pull the capsule forward around the lens equator, thus tightening it and drawing the zonule tangentially forward onto the anterior surface of the lens. The lines of stress on the capsule are evenly distributed in all meridians, thus minimizing capsular rupture. So placed at a mechanical disadvantage, the zonule is more easily ruptured, often by traction alone.

Each, $17.00

Instrument Makers To The Profession Since 1895

V. Mueller and Company 320-340 S. Honore St. Chicago 12, Illinois

Your "experience exchange" in the field of Skin Diseases and Syphilis—A valuable guide in your Practice—

A. M. A. Archives of DERMATOLOGY and SYPHILOLOGY

SIGNIFICANT DEVELOPMENTS reported monthly to the specialist and the physician in general practice. From hospitals, clinics and government treatment centers here and abroad, A. M. A. Archives of DERMATOLOGY and SYPHILOLOGY gathers news of current trends in treatment and diagnosis, group case studies, clinical notes and comments on cutaneous conditions and syphilis.

Well illustrated.

Ably edited.

AMERICAN MEDICAL ASSOCIATION

535 N. Dearborn St., Chicago 10, Illinois.

Please Begin My Subscription to A. M. A. Archives of DERMATOLOGY and SYPHILOLOGY with the Next Issue.

.....M.D.

.....STREET

.....CITY AND STATE

$12.00 YEARLY

$13.50 FOREIGN $12.40 CANADIAN

Opticianry Clinic Notes

OPHTHALMIC PROBLEMS AND DEVELOPMENTS

CLEAR TO THE EDGE

The illustrations depict the result of peripheral aberrations in various types of lenses. In each chart the lowest line of type is seen through the center of the lens. The upper lines are seen through those portions of the lenses away from the optical center. Two facts are at once evident:

1. All "forms" of lenses, whether bi-convex (or bi-concave), plano-convex (or plano-concave), toric, or corrected curve are refractively equal at their centers.

2. As one looks through the portions of the lenses away from the centers, the refractive qualities are entirely different *unless the lenses are properly designed.*

Marginal astigmatism and marginal power changes, which are responsible for the distortion in the two upper charts are eliminated or greatly reduced when the proper "form" of lens is designed for any given correction. Benson Orkon, corrected curve, lenses meet all design requirements that make possible a wide undistorted field of view.

Interpreting your prescription into glasses that DO what YOU want them to do for the patient is our specialty!

N. P. BENSON OPTICAL COMPANY

Since 1913

MAIN OFFICE AND LABORATORY: MINNEAPOLIS, MINN.

Branch Laboratories in Principal Cities of Upper Midwest

Enlarged to show mesh

Exact size

THE NEW CUTLER-HAMBLIN ALL TANTALUM IMPLANT

The latest Cutler Implant for use in enucleations, re-implantations and eviscero-enucleations is described by Dr. Norman Cutler in the February, 1949 issue of the American Journal of Ophthalmology in which he mentions the objectives to be strived for in an ideal implant and prosthesis.

Hamblin's model illustrated herewith is made entirely of Tantalum (a completely inert metal) thereby overcoming the many disadvantages of one made wholly or partly of Plastic. The total weight is 4.3 grammes.

As will be seen in the illustrations, it consists of a ball measuring 17.5 mm. in diameter and 15.5 mm. deep. On the anterior surface is a raised area 12 mm. in diameter and 1 mm. deep, which makes the anterior-posterior length 16.5 mm. The implant is made purposely this size to replace the amount of volume necessarily lost in the removal of the globe and to provide the normal centre of rotation for the prosthesis.

The anterior convex surface of the implant is covered with a fine mesh of tantalum wire behind which is a space sufficient to permit the easy passage of curved suture needles. The adoption of the mesh is the chief feature of the new implant, and the enlarged picture shows the formation of this mesh, which not only offers a larger area for fixation of tissue to the implant but also makes for simplicity in the operation of suturing and more certainty in the fixation.

Price $26.60

THEODORE HAMBLIN Ltd.
DISPENSING OPTICIANS
and
MAKERS OF OPHTHALMIC INSTRUMENTS
15. WIGMORE STREET
LONDON, W. 1. ENGLAND.

For Cases of Low Visual Acuity

Spectel
TELESCOPIC SPECTACLES

with Coated Lenses throughout

Available in two powers. Spectel telescopic spectacles provide retinal image magnification of 1.7 or 2.2 diameters. Experience has shown that they effect substantial improvement in many cases of subnormal vision.

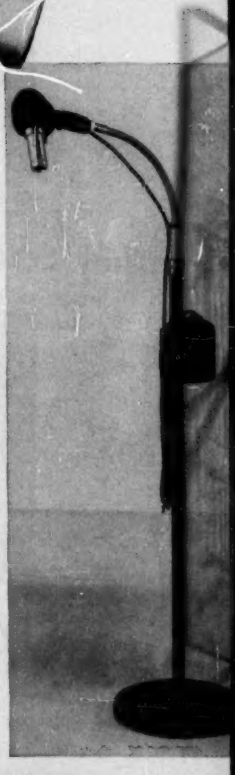
Prescribing Spectel telescopic spectacles is largely an extension of regular refracting routine. Trial sets are neither complicated nor costly. Full details are given in Bulletin 302, which can be obtained from your supplier or direct from us.

KOLLMORGEN *Optical* CORPORATION
2 Franklin Avenue
Brooklyn 11, New York

Distributed in Canada by Imperial Optical Company.

AO OPERATING LAMP

throws the SPOT where you WANT IT



Designed for eye, ear, nose, and throat work specifically, but widely used for many other operative procedures, the AO Operating Lamp gives an intense, uniformly illuminated spot of light when you want it, where you want it. The size of the spot is adjustable by means of an iris diaphragm.

Unique body design combines maximum illumination with efficient heat dissipation. Aluminum and plastic parts maintain streamlined beauty, strength, and lightness. Note these special features:

- ★ **Conversion made easily from hand to floor use (and the reverse). Adapter on stand screws directly into butt of pistol grip.**
- ★ **Right angle mirror on lens tube provides complete versatility in spotting light.**
- ★ **Flexible gooseneck places lamp in any desirable position.**
- ★ **Ultraviolet and heat filters for simple insertion, singly or in combination, are available at nominal cost.**

Call your AO Sales Representative. He will be glad to arrange a demonstration.

American Optical COMPANY

INSTRUMENT DIVISION • BUFFALO 15, NEW YORK

A NEW IDEA FOR THE ONE THING THESE PEOPLE HAVE IN COMMON...

These people...all people...want

They LOOK young when they SEE young with CV's

Continuous Vision Lenses

Are Guaranteed by

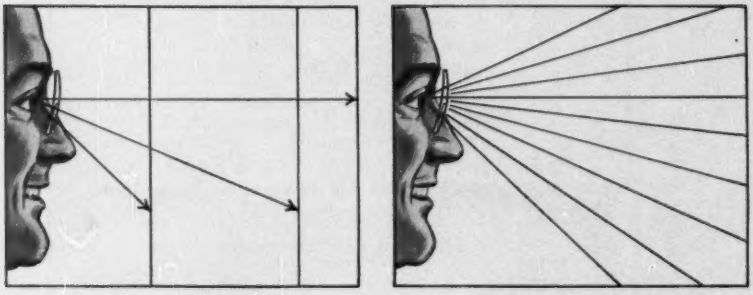
THE UNIVIS LENS COMPANY

1926—A QUARTER CENTURY OF OPTICAL PROGRESS—1951

Research Keeps Univis First

you to prescribe just one thing...

Continuous Vision



Not Three Fields . . . but . . . Continuous Vision

It has been estimated that there are about 30,000,000 people in this country between the ages of 45 and 64. The one thing most of them have in common is a loss of accommodation which prevents them from enjoying Continuous Vision, vision in all distance ranges away from their eyes.

Many of you will say, "That is the condition for which I've been prescribing *trifocals.*" You have been right. For Continuous Vision Lenses ARE trifocals . . . without the unfortunate name-inspired suggestion that they will be harder to wear than bifocals.

The study, "Ranges of Clear and Comfortable Vision Through Multifocal Lenses", by V. J. Ellerbrock, Ph. D., and K. S. Zinnecker, B. Sc., Ohio State University, establishes the fact that patients requiring additions of 1.25 D. or greater find clear, comfortable "continuous vision" only with lenses of three focal powers. You can get a copy of this study by writing The Univis Lens Company.

Of course, thousands of such presbyopes are wearing trifocals now. But thousands more, because they were unable to overcome the apprehension arising out of the name, trifocals, are not. These people are even now accepting the prescription of Continuous Vision Lenses . . . and you get credit as well as the resulting benefit to your practice. Your Univis Prescription Grinding Laboratory now has Continuous Vision Lenses in stock. We will be glad to send you further details.

THE UNIVIS LENS COMPANY
DEPT. A, DAYTON 1, OHIO

E. B. Meyrowitz

SURGICAL INSTRUMENTS CO., INC.,
520 FIFTH AVENUE, NEW YORK 18, N. Y.
LONDON ESTABLISHED 1875 PARIS

SCHIOTZ TONOMETER

Now Available for Immediate Delivery

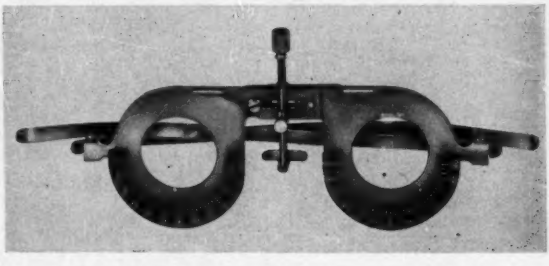
This instrument has long been considered by many Ophthalmologists the most efficient means for determining ocular tension.

As made in our own laboratories it now preserves all of its original effectiveness, with a new margin of accuracy, sturdiness, ease of handling and beauty of finish that is characteristic of instruments made by Meyrowitz.

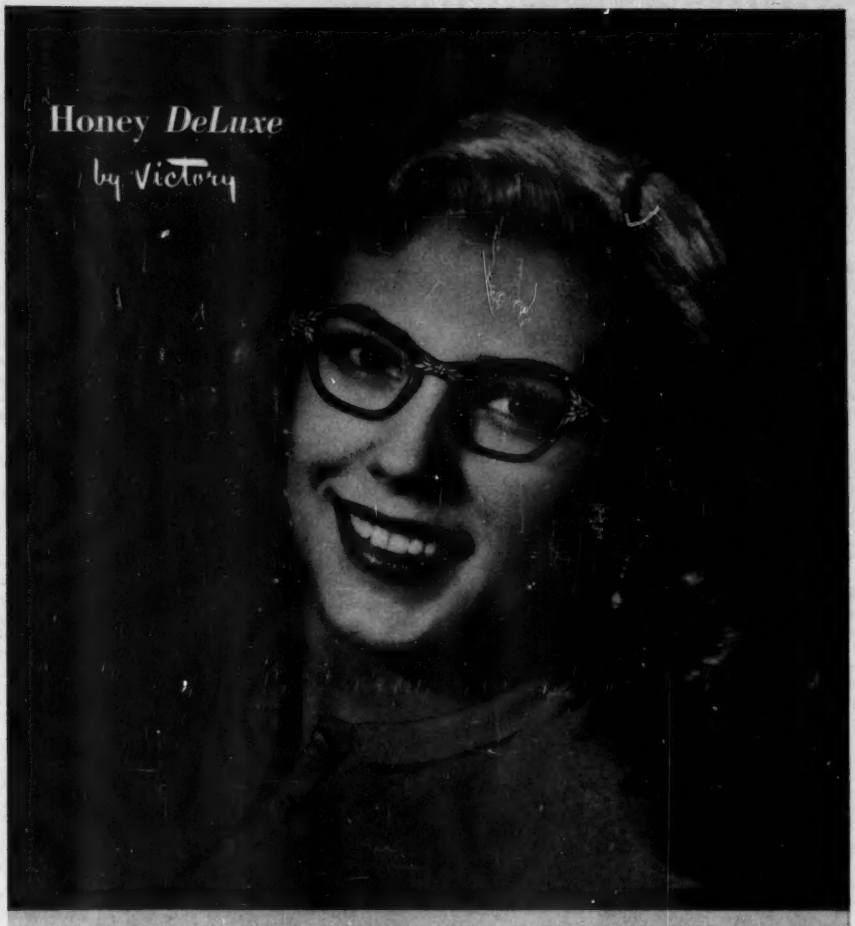
It has been found satisfactory by many Ophthalmologists and meets all the specifications of The Tonometry Committee of The American Academy of Ophthalmology and Otolaryngology. As tested by The Electrical Testing Laboratories, it leaves nothing to be desired from the standpoint of accuracy.

In case, with certification, each $50.00

GRIFFITH-ROGERS TRIAL FRAME



This trial frame is a simple but sturdy and easily adjustable frame that is designed for rapid routine examinations over a long period of time. It will stand hard usage. Interpupillary distance is adjustable by means of a rack and pinion and the bridge height is adjusted by the same knob. Bridge may be locked. Temples are of spring steel to support the frames in position. Protractor is black with white letters and there are two front and one rear pairs of slots for the trial lenses. In stainless steel. **Price $25.00**



The tasteful simplicity of DELUXE ornamentation (1/10 12K gold-filled) adds a charming touch to Honey's high fashion styling.

In subdued metallic tones, and standard colors.

The same DELUXE trim in other popular Victory frames —Rosalie, Bell, Bellaire, and V-Set Karen.

Available Through Your Optical Supplier

VICTORY OPTICAL MANUFACTURING COMPANY

Quintet of Quality

Made by experts for experts . . . these *National* EENT instruments are paid the most telling tribute of all: *each year more and more doctors purchase and use more and more of these dependable, efficient diagnostic aids.*

"Center-of-Beam" HEADLIGHT

With reflecting mirror for oblique lighting and sight opening for sharp, shadow-free vision directly through center of beam. Instantly convertible to direct type headlight.

Lifetime Guaranteed DIAGNOSTIC SET

Includes Double-Disc Ophthalmoscope, Standard Otoscope with Metal Head, 6 Spatula, Tongue Depressor Holder, Straight Metal Transilluminator, Laryngeal Clip-Mirror, Spare Bulbs, Case. User-Lifetime warranty with set.

For Eustachian Inspection NASOPHARYNGOSCOPE

With exclusive Foster Lens System. Remarkable brilliance, sharpness and improved magnification over greater width of field. Clearer, longer, sharper inspection.

Lifetime Guaranteed OTOSCOPE

All-Metal Head, Brighter-than-ever-illumination with economic, easy-to-replace flashlight bulb; "Lazy-Latch" Holder grips speculs firmly yet permits one-motion removal.

Instant Comparison TWIN TRANSILLUMINATOR

Simultaneous and positive comparison of both sinuses, eyeballs, pupils, lenses, anterior chambers, conjunctivae, etc. Adjustable to all facial measurements.

Valuable additions to your reference library — write for them today: "What the General Practitioner Should Know About Ophthalmoscopic Examinations" and "Post-Nasal Discharge."

Use coupon below

For full details concerning any of these instruments mail the coupon below.

National

ELECTRIC INSTRUMENT CO., Inc.

92-21 Corona Ave., Elmhurst, L. I., N. Y.

World-Famous Makers of Electro-Medical Instruments

National Electric Instrument Co., Inc.
Dept. AO., 92-21 Corona Ave., Elmhurst, L. I., N. Y.

☐ Send me the booklets offered above.

Send me additional data on National's

☐ Headlight ☐ Diagnostic Set ☐ Otoscope
☐ Nasopharyngoscope ☐ Twin-Transilluminator

Name.....

Address.....

City..... Zone.... State.....

CONTENTS

PAGE

Retinal Detachment and Aphakia. CHARLES L. SCHEPENS, M.D., BOSTON..... 1

Retinal Correspondence in Patients with Small Degree Strabismus. ARTHUR JAMPOLSKY, M.D., SAN FRANCISCO..... 18

Nitrogen Fractions as Criterion of Preservation of Corneal Tissue. WILHELM BUSCHKE, M.D.; AUDREY HOWARD, B.A., AND LUCY SIEGEL, B.A., NEW YORK..... 27

Greater Superficial Petrosal Neurectomy for Relief of Chronic Bullous Keratitis. LORAND V. JOHNSON, M.D., AND WILLIAM A. NOSIK, M.D., CLEVELAND..... 32

Cerebellar-Macular Abiotrophy. WILLIAM H. HAVENER, M.D., ANN ARBOR, MICH... 40

Clinical Trial with Chloramphenicol in Ocular Infections. IRVING H. LEOPOLD, M.D., PHILADELPHIA..... 44

Investigation of Visual Space: The Blumenfeld Alleys. LE GRAND H. HARDY, M.D.; GERTRUDE RAND, PH.D., AND M. CATHERINE RITTLER, A.B., NEW YORK..... 53

Amblyopia Independent of Usual Associated Conditions. JOSEPH W. HALLETT, M.D., PHILADELPHIA..... 64

Hysterical Amblyopia in Children and Young Adults. ELTON R. YASUNA, M.D., WORCESTER, MASS..... 70

CLINICAL NOTES:

An Improved Light Source for the Zeiss-Nordenson Fundus Camera. GLEN FLOYD, M.D., WINFIELD, KAN., AND R. B. STITH, SAN DIEGO, CALIF..... 77

OPHTHALMOLOGICAL REVIEWS:

Peripheral Visual Acuity. FRANK N. LOW, PH.D., NEW ORLEANS..... 80

ANNUAL REVIEWS:

Lids, Lacrimal Apparatus and Conjunctiva: Review of Recent Literature. JAMES H. ALLEN, M.D., NEW ORLEANS..... 100

CORRESPONDENCE:

Postoperative Diplopia. HERMANN M. BURIAN, M.D., BOSTON..... 120

The Crossed Cylinder Test. VICTOR PURVIS, M.B., D.O., OXFORD, ENGLAND..... 121

NEWS AND NOTES..... 122

THE A. M. A. ARCHIVES OF OPHTHALMOLOGY is published by the American Medical Association to continue the *Archives of Ophthalmology*, founded by Herman Knapp in 1869, and to provide American ophthalmologists with a publication devoted not only to original contributions in the field of ophthalmology but to a survey of the ophthalmologic literature and a review of the transactions of ophthalmologic societies.

Communications regarding subscriptions, reprints, etc., should be addressed, A. M. A. ARCHIVES OF OPHTHALMOLOGY, American Medical Association, 535 North Dearborn Street, Chicago 10.

Manuscripts for publication, books for review and correspondence relating to the editorial management should be sent to Dr. Francis Heed Adler, Chief Editor, 313 South Seventeenth Street, Philadelphia 3.

Articles are accepted for publication on condition that they are contributed solely to the A. M. A. ARCHIVES OF OPHTHALMOLOGY. Manuscripts must be typewritten, preferably double spaced, and the original copy should be submitted. Zinc etchings and halftones will be supplied by the Association when the original illustrations warrant reproduction and when their number is not considered excessive.

Footnotes and bibliographies (the latter are used only in exhaustive reviews of the literature) should conform to the style of the *Quarterly Cumulative Index Medicus*, published by the American Medical Association. This requires, in order given: name of author, title of article and name of periodical, with volume, page, month—day of month if the journal appears weekly—and year.

Matter appearing in the A. M. A. ARCHIVES OF OPHTHALMOLOGY is covered by copyright, but as a rule no objection will be made to its reproduction in a reputable medical journal if proper credit is given. However, the reproduction for commercial purposes of articles appearing in the A. M. A. ARCHIVES OF OPHTHALMOLOGY or in any of the other publications issued by the Association will not be permitted.

The A. M. A. ARCHIVES OF OPHTHALMOLOGY is issued monthly. The annual subscription price (for two volumes) is as follows: domestic, $12.00; Canadian, $12.40; foreign, $13.00, including postage. Current single copies are $1.25, postpaid.

Checks, money orders and drafts should be made payable to the American Medical Association.

OTHER PERIODICAL PUBLICATIONS
of the American Medical Association

THE JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION—Weekly. Covers all the medical sciences and matters of general medical interest. Illustrated. Annual subscription price (three volumes): domestic, $15.00; Canadian, $16.50; foreign, $19.00. Single copies, 45 cents.

A. M. A. ARCHIVES OF INTERNAL MEDICINE—Monthly. Devoted to the publication of advanced original clinical and laboratory investigations in internal medicine. Illustrated. Annual subscription price (two volumes): domestic, $10.00; Canadian, $10.40; foreign, $11.00. Single copies, $1.00.

A. M. A. ARCHIVES OF NEUROLOGY AND PSYCHIATRY—Monthly. A medium for the presentation of original articles on nervous and mental diseases, with abstracts from foreign and domestic literature, book reviews, transactions of special societies, etc. Illustrated. Annual subscription price (two volumes): domestic, $12.00; Canadian, $12.40; foreign, $13.50. Single copies, $1.25.

A. M. A. ARCHIVES OF DERMATOLOGY AND SYPHILOLOGY—Monthly. Devoted to advancing the knowledge of and progress in cutaneous diseases and syphilis. Publishes original contributions on these two subjects, transactions of the important dermatological societies, book reviews, etc. Illustrated. Annual subscription price (two volumes): domestic, $12.00; Canadian, $12.40; foreign, $13.50. Single copies, $1.25.

A. M. A. AMERICAN JOURNAL OF DISEASES OF CHILDREN—Monthly. Presents pediatrics as a medical science and as a social problem. Includes carefully prepared reviews, based on recent pediatric literature, abstracts from foreign and domestic literature, book reviews, transactions of special societies, etc. Illustrated. Annual subscription price (two volumes): domestic, $12.00; Canadian, $12.40; foreign, $13.50. Single copies, $1.25.

A. M. A. ARCHIVES OF SURGERY—Monthly. Devoted largely to the investigative and clinical phases of surgery, with monthly reviews on orthopedic and urologic surgery. Well illustrated. Annual subscription price (two volumes): domestic, $14.00; Canadian, $14.40; foreign, $15.50. Single copies, $1.25, except special numbers.

A. M. A. ARCHIVES OF OTOLARYNGOLOGY—Monthly. A medium for the presentation of original articles on diseases of the ear, nose and throat, with abstracts from foreign and domestic literature, book reviews, transactions of special societies, etc. Illustrated. Annual subscription price (two volumes): domestic, $12.00; Canadian, $12.40; foreign, $13.00. Single copies, $1.25.

A. M. A. ARCHIVES OF PATHOLOGY—Monthly. A periodical devoted to the publication of original articles and general reviews in the field of pathology. Illustrated. Annual subscription price (two volumes): domestic, $8.00; Canadian, $8.40; foreign, $9.00. Single copies, $1.00, except special issues.

A. M. A. ARCHIVES OF INDUSTRIAL HYGIENE AND OCCUPATIONAL MEDICINE—Monthly. Devoted to the advancement of knowledge of the diseases of industry and to the publication of scientific investigation in this field. Illustrated. Annual subscription price (two volumes): domestic, $8.00; Canadian, $8.40; foreign, $9.00, including postage. Single copies, $1.00.

QUARTERLY CUMULATIVE INDEX MEDICUS—A complete subject and author index to the worth while current medical literature of the world. Issued twice a year. Volumes bound for permanent reference. Subscription price, calendar year: domestic, $20.00; Canadian, $22.00; foreign, $22.00.

AMERICAN MEDICAL ASSOCIATION

535 North Dearborn Street **CHICAGO 10**

A. M. A.
ARCHIVES OF OPHTHALMOLOGY

VOLUME 45 JANUARY 1951 NUMBER 1

COPYRIGHT, 1951, BY THE AMERICAN MEDICAL ASSOCIATION

RETINAL DETACHMENT AND APHAKIA

CHARLES L. SCHEPENS, M.D.
BOSTON

DURING 1948 and 1949, 387 cases of detachment were referred to the Retina Service of the Massachusetts Eye and Ear Infirmary for treatment. Cases of aphakia numbered 88, or 23 per cent. In eight cases there were bilateral aphakia and detachment.

The purpose of this paper is to analyze our findings and discuss our results in cases of detachment and aphakia. I shall attempt to determine some of the important factors in the causation of the disease. Practical points which will be discussed may help in making an early diagnosis and in facilitating examination of the fundus. Surgical technic will not be discussed.

In eyes with detachment and aphakia, what is the relation between the aphakia and the detachment? Is the second a complication of the first; are they two independent conditions which happen to coexist in a certain number of patients, or are detachment and cataract closely related because they have the same, and as yet unknown, primary cause? If the last hypothesis proves to be true, detachment in aphakic patients would constitute a separate clinical entity, differing in several ways from detachment in phakic patients.

TYPE OF DETACHMENT; LOCATION OF RETINAL BREAKS

In attempting to classify detachments in general according to their morphological appearance, it seems fitting to divide them into three types. In the first type detachments are produced by lesions at or near the equator; most detachments in myopes belong to this class. In the second type the pathological changes are at or near the ora serrata; most detachments in aphakic eyes are of this type. It should be remembered, however, that some detachments in myopes show changes near the ora serrata and that a few detachments in aphakic patients show equatorial changes. In the third type, which may be called the mixed type, there are changes near both the ora serrata and the equator.

If an unselected series of detachments in phakic patients is compared with our series of detachments in aphakic patients, it is noted that mixed changes are equally common in the two series (table 1). Equatorial changes are seen in about 11 per cent of the aphakic patients and in 47 per cent of the phakic patients. On the other hand, changes near the ora serrata are more than twice as frequent in aphakic as in phakic patients. In other words, detachments in eyes with aphakia

This work was carried out with the aid of grants from the American Optical Company, the Vivian B. Allen Foundation and the Veterans Administration.

Read before the Section on Ophthalmology, at the Ninety-Ninth Annual Session of the American Medical Association, San Francisco, June 30, 1950.

show changes near the ora in a large proportion of cases, whereas detachments in phakic eyes show mostly equatorial changes. As myopes with detachment generally have equatorial changes, relatively few myopes might be expected among our aphakic patients with detachment, and this was found to be the case. The state of refraction was known for 78 patients, and only 37 per cent had axial myopia before their cataract extraction, whereas series of detachments in general contain about 60 per cent of myopes.[1]

Schepens and Bahn [2] have pointed out that the poorer prognosis of detachment in eyes with aphakia is probably a result of the difficulty of adequate examination, for the retinal breaks are often small, multiple and located at the extreme periphery, near the ora serrata. It is obvious that if they are multiple and are not detected by preoperative examination of the fundus, there is little chance of reattachment by operation. They have also discussed the fact that breaks often cannot be seen by direct ophthalmoscopy. In many cases of detachment in aphakic patients the region which requires the most careful study extends from the equator to the ciliary processes. Only a small portion of this area is accessible to direct ophthalmoscopy. I found that the most useful instrument for examination of the extreme periphery

TABLE 1.—*Location of Retinal Changes Leading to Detachment in Phakic and in Aphakic Eyes*

	Phakic Patients Seen in 1948 (100 Eyes)		Aphakic Patients Seen in 1948 and 1949 (88 Eyes)	
	Number of Patients	Percentage	Number of Patients	Percentage
Changes near ora	43	30	52	66
Mixed changes	33	23	18	23
Equatorial changes	67	47	9	11
Total	143	100	79	100

is an indirect stereoscopic ophthalmoscope with a scleral depressor.[3] It is of importance to dilate the pupil to its maximum and then examine the patient both in a sitting and in a lying position.

An analysis of our cases reveals that one or several breaks were detected by direct ophthalmoscopy in 35 eyes, or 44 per cent, of 79 eyes which were carefully examined. In nine of a total of 88 cases search was not made for retinal breaks because no operation was contemplated. Bagley [4] found breaks in 38.4 per cent of his cases, and Shapland,[5] in 40 per cent. In 26 of the 35 cases (74 per cent) in which we found breaks with direct ophthalmoscopy, additional breaks were detected with our method of indirect ophthalmoscopy. After examination by this method, we found one or more breaks in 77 of 79 eyes, or in 97.5 per cent of all eyes carefully examined. There were only 10 of 79 eyes (11 per cent) in which no more than one retinal break was detected. The average number of breaks for 79 eyes was

1. Amsler, M., and Schiff-Wertheimer, S.: Traité d'opht. **5**:525-622, 1939. Duke-Elder, W. S.: Textbook of Ophthalmology, vol. 3, St. Louis, C. V. Mosby Company, 1940, pp. 2864-2926.

2. Schepens, C. L., and Bahn, G. C.: Examination of the Ora Serrata: Its Importance in Retinal Detachment, Arch. Ophth. **44**:677-690 (Nov.) 1950.

3. Schepens, C. L.: Tr. Am. Acad. Ophth., to be published.

4. Bagley, C. H.: Am. J. Ophth. **31**:285-298, 1948.

5. Shapland, C. D.: Tr. Ophth. Soc. U. Kingdom **54**:176-196, 1934.

4.45 per eye, and as many as 16 breaks were counted in one eye. More than 80 per cent of all the breaks detected were not visible with the usual methods of direct ophthalmoscopy.

It is obvious that this evaluation of direct ophthalmoscopy for detection of retinal breaks is only approximate, because there are often discrepancies in the ophthalmoscopic findings of different observers. Some of the retinal breaks which were not seen by direct ophthalmoscopy might possibly have been detected by more expert and more patient observers. Nevertheless, the fact remains that even when a strong light source was used a large number of the breaks detected by our method of indirect ophthalmoscopy could not be seen with the present methods of direct ophthalmoscopy.

It has been mentioned elsewhere [2] that changes in the ora serrata associated with detachments often produce retinal breaks of two types—small dialyses and breaks closely related to meridional folds. These meridional folds usually appear over the teeth of the ora serrata, seldom over its bays. Of 70 eyes showing changes in the ora serrata, we found either meridional folds or small dialyses or both in 50, or 71 per cent (table 2).

TABLE 2.—*Analysis of Changes in Ora Serrata Associated with Detachment in Seventy Aphakic Eyes**

	Number of Eyes	Percentage
Meridional folds only	23	33
Small dialyses only	15	21
Folds and dialyses	12	17
Other ora changes	20	29
Total	70	100

* In nine eyes (11 per cent) there were no changes in the ora, the lesion being located near the equator.

Meridional folds were found in 35 cases, or 50 per cent, and a retinal break was detected close to the posterior end of the fold in 18 cases, or about 26 per cent. In 27 cases, or 38 per cent, one or several small dialyses were detected, each dialysis occupying but one ora bay. This statistic confirms my former impression that the changes described are among those most frequently seen in detachments with pathologic changes in the ora serrata.

SUBCLINICAL DETACHMENT

This term is used to designate detachments too peripheral to cause a diminution of visual acuity and marked constriction of field. In a number of cases subclinical detachments were not detectable with a direct ophthalmoscope. Aphakic patients are probably affected by this type of detachment oftener than others. It has been seen that most detachments in aphakic eyes show pathological changes near the ora serrata and that resulting retinal breaks are usually very small. In the early stages, detachment is often flat and fairly smooth, making diagnosis difficult. It may be present long before the patient is aware of it, because it develops insidiously from the extreme periphery toward the posterior pole.

Mr. O. T. (Retina Service 123) was referred to me because of a detachment in the right eye, which had been present for two years. Bilateral uncomplicated intracapsular cataract extraction had been performed several years before. On examination, the detachment in the right eye

appeared hopeless. In the left eye, vision with correction was 20/30, but there was a slight nasal constriction of the field. Ophthalmoscopic examination under full dilation showed an early temporal detachment with three breaks near the ora serrata. Operation was performed on the left eye, with success.

In this case, the incipient detachment was discovered by perimetric examination, but even with careful perimetry one is not always certain of detecting an early detachment. This is illustrated by the following cases:

Mrs. H. B. (Retina Service 674), aged 49, had an uncomplicated intracapsular cataract extraction performed on the right eye. Two weeks later a detachment suddenly developed in this eye, for which operation was unsuccessful. The left eye was then carefully examined. With a weak myopic correction vision was 20/30, and the visual field was entirely normal. Ophthalmoscopic examination showed a very small inferior detachment, in the middle of which was a tiny round hole. This detachment was not treated surgically.

Mr. J. H. (Retina Service 688) had bilateral uncomplicated cataract extraction ten years before. Six years prior to the present admission a detachment developed in the right eye, for which operation was successful, and a year later he was treated for chronic simple glaucoma in both eyes. On examination, vision with correction was 20/40 in the right eye and 20/30 in the left eye. The visual fields showed bilateral glaucomatous changes. Examination of the fundus of the right eye revealed the scar of the previous retinopexy [6] and an apparently fresh, horseshoe-shaped tear at 10 o'clock, surrounded by a small detachment. The left eye showed two small round holes at 11 o'clock near the ora serrata, surrounded by a flat detachment. The patient was kept under observation.

Many other examples of subretinal detachment could be cited. It is not known how long such lesions may be present before seriously interfering with the patient's vision. It is likely, however, that in a number of cases a long time may elapse before a large detachment occurs. In some cases, even, a large detachment may never appear. As will be seen later, it is probably possible to detect a much greater number of subclinical detachments by systematic examination of certain types of patients. It should be remembered, however, that detachments do not always begin insidiously. Tears forming near the equator often cause a detachment that affects the patient's vision at an early stage.

VITREOUS RETRACTION

Another important feature of detachment in aphakic eyes is the occurrence of what may be called massive vitreous retraction. As far as we are able to determine, the hyaloid membrane in such cases remains adherent to the retina and shrinks, causing a detachment which rapidly becomes total.

There are two principal ophthalmoscopic characteristics of massive vitreous retraction. First, all the retinal folds are fixed, so that when the eye moves they remain immobile and do not change in shape or position. Second, the fixed retinal folds radiate from the posterior pole of the globe toward the equator. Near the equator, and running parallel to it, is a circular fixed fold, to which visible vitreous strands are frequently attached. The circular fold generally makes a sharp ridge in the fundus. When massive vitreous retraction has been present for several months, it often loses its characteristic appearance. The condition never improves with bed

6. This word is used at the Retina Service of the Massachusetts Eye and Ear Infirmary to designate any type of surgical procedure which aims at reattachment of the retina. It is derived from the Greek word πῆξις, which means "a nailing together; fixation."

rest. If the subretinal fluid is allowed to escape and saline solution is injected into either the anterior chamber or the vitreous, the retina flattens out somewhat, but the folds retain their general shape.

There are mild forms of vitreous retraction in which fixed folds are limited to one or two areas of the fundus. Such fixed folds are often star shaped and tend to occur either at the macula or in the inferior half of the fundus. Although the prognosis is never good when fixed folds are present, it somewhat depends on their number, location and extension. The total number of aphakic eyes with vitreous retraction reaches the impressive figure of 40 out of 88, or 45 per cent. Mild degrees of vitreous retraction were observed in 19 eyes.

Aphakic eyes with detachment are undoubtedly oftener affected by massive vitreous retraction than are phakic eyes with detachment. Among 160 consecutive cases of detachment in phakic eyes seen in 1948, there were 12, or 7.5 per cent, with massive vitreous retraction, occurring either prior to or after operation. On the other hand, there were 21, or 24 per cent, among 88 aphakic eyes with detachment. The data summarized in table 3 show that in our aphakic patients preoperative massive vitreous retraction was present in 14 eyes, or 16 per cent. In

TABLE 3.—*Incidence of Massive Vitreous Retraction in Eighty-Eight Aphakic Eyes with Retinal Detachment*

	Massive Vitreous Retraction			Total No. of Eyes	Percentage
	Pre-operative	Post-operative	Total		
Patients above 50	7	2	9	65	14
Patients under 50	4	4	8	15	53
Patients with vitreous loss	3	1	4	8	50
Total	14	7	21	88	24

seven eyes, or 8 per cent, it appeared postoperatively. It is difficult to decide whether this postoperative complication was due to the operative procedure or whether it was the result of a progressive change which would have occurred regardless of the operation. It may be that the operation precipitated the course of a slowly progressive alteration, without actually causing it. As this complication strongly affects the prognosis, it is extremely important to find its cause.

Aphakic patients under 50 years of age appear more susceptible to vitreous retraction than older persons. Eight of 15 patients in this group, or 53 per cent, had massive vitreous retraction. In an unselected series of detachments in phakic patients, we found that most cases of massive vitreous retraction also occurred in patients under 50 years of age. We believe, therefore, that massive vitreous retraction occurs more frequently in the young, regardless of whether or not the lens has been extracted.

Massive vitreous retraction also seems more frequent when there has been loss of vitreous. It was observed in four of eight eyes with loss of vitreous, whereas in aphakic patients in whom there was no loss of vitreous it was present in only 17 of 80 eyes, or in 21 per cent.

When patients with loss of vitreous and patients under 50 years of age are excluded, it is noted that there were nine patients with massive vitreous retraction among 65, or 14 per cent. If, similarly, one considers a series of 77 phakic patients

over 50 years of age and with a detachment, one finds only three with massive vitreous retraction, or about 4 per cent. The factors accounting for this discrepancy may now be considered.

Vitreous retraction is more frequent with detachments of long standing. Late diagnosis may be one of the reasons for its frequent occurrence in aphakic eyes. However, in aphakic, as well as in phakic, eyes there is considerable, and as yet unexplained, individual variation in the tendency toward development of vitreous retraction. For example, we have seen a detachment of 16 years' duration without vitreous retraction, but in other cases the complication has occurred at an early stage.

Aside from late diagnosis a reason for the development of vitreous retraction in aphakic eyes may be the frequency of changes near the ora serrata. These changes probably affect the base of the vitreous, causing profound disturbances in the whole vitreous body.

As the real nature of massive vitreous retraction cannot be understood without considerable research, we have provisionally accepted the hypothesis that it is due to a disturbance of the hyaloid membrane. However, there are indications that the retina itself is affected at an early stage, and it is likely that the limiting membranes of the retina also play an important role in this condition. We must, therefore, emphasize that the term massive vitreous retraction is only provisional and may prove to be ill chosen.

When massive vitreous retraction was present, none of the surgical procedures used, including scleral resections and scleral bucklings, have been of any avail. It is therefore extremely important to recognize this condition. I ascribe most of my failures in phakic, as well as in aphakic, eyes to the presence of clinically detectable retraction of the vitreous. In old detachments vitreous retraction is probably the main factor which prevents reattachment. This is not yet widely recognized, as some authors, e. g., Arruga,[7] stress the factor of congestion of the choroid and loss of its power to absorb the residual subretinal fluid after the operation. Pischel and others speak of shrinkage of the retina and have resorted to scleral resection in order that the choroid may be allowed to fit over the shrunken retina.[8] The influence of these two factors cannot be denied, but they are probably second in importance to vitreous retraction.

TYPE OF CATARACT OBSERVED BEFORE DETACHMENT

The type of pathologic change in the lens present before extraction was fairly accurately described in the records of 62 of 88 cases (table 4). In 29 eyes, or 47 per cent, there were well developed posterior cortical opacities, sometimes associated with nuclear sclerosis. In 15 cases, or 24 per cent, either the lens showed a mature cataract or the type of lens opacity was not described, but in the fellow eye well developed posterior cortical opacities were observed. Consequently, a posterior cortical cataract was present either in the affected eye or in the fellow eye in 44 cases, or 71 per cent. Nuclear sclerosis or senile wedge-shaped opacities in the cortex were observed in only 13 cases, or 21 per cent. In five cases, or 8 per cent,

7. Arruga, H., in Sorsby, A.: Modern Trends in Ophthalmology, New York, Paul B. Hoeber, Inc., 1947, vol. 2, pp. 332-336.

8. Leopold, I. H., in discussion on Pischel, D. K.: Tr. Am. Acad. Ophth. 49:155-171, 1945.

the lens showed some other type of opacity. These data are not as accurate as might be wished, because they are based on observations made by various observers, who perhaps did not use the same standards for classification of cataract. It is interesting, however, to note that the percentage of posterior cortical cataracts in our cases is several times as high as the percentage found by Kirby [9] in a large group of patients showing opacities of the lens. Of 945 patients, this author found only 15 per cent with posterior cortical cataracts, either alone or associated with other types of lenticular opacities.

The eyes with posterior cortical cataract very often showed a mixture of subcapsular opacities with scattered opacities in the posterior cortex. The subcapsular opacities began as an apparent roughening of the affected area, which appeared irregular and iridescent. The changes spread from the posterior pole toward the equatorial region. In some cases they consisted of a saucer-shaped cataracta complicata; in other cases, the subcapsular changes were associated with opacities in the posterior cortex. Some of these were dustlike, causing a yellowish cortical haze,

TABLE 4.—*Type of Lenticular Lesion Observed in a Series of Eighty-Eight Aphakic Eyes with Retinal Detachment*

	Number of Eyes	Percentage
Posterior cortical opacities	29	47
Posterior cortical opacities in fellow eye	15	24
Nuclear sclerosis or wedge-shaped opacities	13	21
Congenital cataract	1	1.6
Dislocation without cataract	2	3.3
Traumatic cataract	2	3.2
Total	62 *	100

* In 26 eyes there was no accurate description of the lens opacities.

while others were composed of scattered white dots. In several cases, a mature cataract eventually developed.

RELATION OF CATARACT SURGERY TO DETACHMENT

Time Relation.—It is probably correct to say that in the opinion of many ophthalmologists the cataract extraction and its complications are the most important causes of detachment in aphakic patients. In an attempt to estimate the etiological importance of cataract extraction, we have divided our cases into two groups (table 5). In the larger group, the first symptoms of detachment were observed some time after the cataract extraction. It contains 69 of the 88 cases, or 78.5 per cent. The detachment occurred as late as 18 years after operation. The fact that in about 40 per cent of all cases of detachment and aphakia the first symptoms of detachment were noted within one year after the cataract operation suggests a causal relation between extraction and detachment. In cases in which the detachment occurred more than one year after the extraction it may be felt that the relationship between cataract operation and detachment is not a very close one.

Our second group of cases contains those in which we are certain that the detachment occurred before the cataract extraction. It includes 19 of 88 cases, or

9. Kirby, D. B.: Pathogenesis of Senile Cataract, Arch. Ophth. **8**:97-119 (July) 1932.

21.5 per cent. Cases of bilateral detachment are of particular interest in connection with this group. Of eight patients with bilateral aphakia and bilateral detachment, four had detachment before the cataract extraction. In addition to detachments occurring before cataract extraction, we have records of five cases of bilateral detachment with unilateral aphakia, again indicating that the cataract extraction was not an etiological factor in the detachment in these cases. We have also observed several cases of successful retinopexy followed by cataract requiring extraction. These facts prove beyond any doubt that in many cases detachment is not the result of cataract extraction.

The existence of subclinical detachments leads us to conclude that some eyes, classified in the group of detachments which occur after cataract operation, probably had their detachment before the extraction of the lens. When there are lenticular opacities, an insidiously developing detachment is extremely difficult to detect. In such a condition, significant subjective symptoms, such as showers of black dots or photopsia, localized in one sector of the visual field, may not be reported by the patient, who sometimes believes that they belong to the clinical picture of a developing cataract. When the lens is hazy, a vitreous hemorrhage of moderate

TABLE 5.—*Time Relation Between Cataract Extraction and Detachment in Eighty-Eight Eyes*

	Number of Eyes	Percentage
Group 1: Detachment after extraction		
Less than 3 mo.	19	21.5
3 mo. to 1 yr.	16	18
1 to 18 yr.	34	39
Group 2: Detachment before extraction	19	21.5
Total	88	100

amount, often the result of rupture of a retinal vessel from a retinal break, may also escape notice by the patient and his ophthalmologist.

Relation to Type of Cataract Surgery.—We attempted to determine whether the procedure by which the cataract was removed had any bearing on the prognosis of retinal detachment (table 6). Our series contains 72 cases of intracapsular cataract extraction, 11 cases of extracapsular extraction and five cases of discission of the lens. The great number of detachments following intracapsular extraction does not necessarily indicate that with this operation retinal detachment is particularly likely to occur. This greater incidence may result from the present general preference for intracapsular extraction over extracapsular extraction. In eight cases with intracapsular extraction the patient either had bare light perception or refused operation. Of the 64 remaining cases, operation was performed in 55. Reattachment of the retina occurred in 34 cases, or 62 per cent, with resulting improvement in visual acuity and fields. No case was classified as one of reattachment unless the retina had remained in situ for at least three months after the last operation. So-called improvements in which part of the retina remained detached were classified as failures. In nine instances of fixed folds or massive vitreous retraction, no operation was advised because we felt that we were unable to improve vision in such cases.

In nine of 11 cases of detachment occurring after an extracapsular cataract extraction retinopexy was performed, with reattachment in four (44 per cent). In two cases no operation was performed because of the presence of massive vitreous retraction. In three of our cases of failure, satisfactory preoperative examination was not feasible because of the presence of lens capsule and the impossibility of dilating the pupil fully.

There was reattachment in only one of five detachments following discission of the lens in young patients. In two instances the anterior chamber was filled with vitreous. The prognosis in these cases seemed particularly poor when the vitreous had been considerably disturbed. The difficulties of preoperative examination were sometimes even greater than after an extracapsular cataract extraction.

The number of detachments following extracapsular extraction or discission of the lens is too small to permit any definite conclusions about their prognosis. However, results are likely to be poorer because of the difficulty of a good preoperative examination.

Relation to Complications of Cataract Surgery.—Some authors seem to think that operative or postoperative complications, such as loss of vitreous, iris prolapse

TABLE 6.—*Result of Retinopexy After Various Types of Lens Surgery in Eighty-Eight Eyes*

	No Operation Advised	Failure	Reattachment	Total
Intracapsular extraction *	9	21	34	64
Extracapsular extraction	2	5	4	11
Discission of the lens	..	4	1	5
Total	11	30	39	80

* In eight eyes with intracapsular cataract extraction there was either bare light perception or the operation was refused. These cases are not included in these statistics.

or uveitis, are often responsible for a subsequent retinal detachment. If this were true, most patients should have a history of complicated cataract extraction or stormy postoperative course.

Of 72 cases of intracapsular extraction with retinal detachment, vitreous loss occurred in only eight, that is, in 11.1 per cent. In none of the 11 cases in which the extracapsular method was used was there loss of vitreous. This low percentage indicates that in our cases loss of vitreous was not a frequent cause of detachment after cataract extraction. The data found in the literature are not in complete agreement with our findings. Hughes and Owens [10] observed that there had been loss of vitreous in 13 of 30 cases with detachment and aphakia. Of Bagley's [4] and Shapland's cases,[5] 20 per cent had loss of vitreous. It is probable that all statistics are too small as yet to be really significant.

It has already been mentioned that when vitreous was lost the prognosis with respect to a subsequent detachment was poor on account of the massive vitreous retraction which frequently followed. This explains why only two out of eight retinopexies were successful in cases with loss of vitreous.

In five cases, or 7 per cent, there was a prolapse of the iris after intracapsular extraction. In two cases operation was performed, with a good result in one. It is

10. Hughes, W. F., and Owens, W. C.: Am. J. Ophth. **28**:40-49, 1949.

worth noting that in two other cases in this series bilateral intracapsular extraction was performed, with prolapse of the iris in one eye and no complication in the other. The detachment, however, occurred in the eye operated on without complication. It seems, therefore, that prolapse of the iris in aphakic patients was a relatively unimportant etiological factor in detachment.

Of all our cases of detachment and aphakia, previous treatment had been given for active choroiditis in three, and broad posterior synechias, resulting from iridocyclitis, were present in four. In addition, 38 eyes were carefully examined with the slit lamp, and 16 showed signs of inflammation, such as folds in the lamina posterior elastica (Descemet's membrane), keratic precipitates and flare and cells in the anterior chamber. A total of 20 eyes out of 88 (23 per cent) had either moderately active or almost quiescent uveitis. It is not always easy to decide whether the inflammation was present before the detachment. One may conceive that the uveitis results from the detachment or, conversely, that the detachment has been produced by the uveitis. Examination of a number of phakic and aphakic eyes has convinced us that in many instances the inflammatory process precedes the detachment and is probably an important etiological factor in this disease. This seems particularly likely when the inflammation is located near the ora serrata.[11] In such cases there may be few, or no, clinical signs of uveitis. This explains why only 8 per cent of all our patients revealed a history of uveitis, whereas 42 per cent of those carefully examined with the slit lamp showed signs of inflammation.

The course of an inflammation near the ora serrata is always a protracted one, perhaps because of poor vascularization in this area. In many cases the sequelae of inflammation near the ora are obliteration of the peripheral retinal vessels, thinning of the retina, formation of large retinal cysts, pigment proliferation in the choroid and retina, choroidal atrophy, dustlike opacities in the vitreous, which are more numerous in the extreme periphery, and vitreous retraction. These changes create very favorable circumstances for the insidious development of a detachment, which may not become apparent for a long time after absorption of exudates in the ora region. They may also be the cause of other conditions often observed in these cases, such as posterior cortical opacities and deep chamber glaucoma.

If peripheral inflammatory changes are a frequent cause of detachment in aphakic patients, it is important to investigate how their presence affects the prognosis of detachment. In eight of 20 patients with uveitis no operation was performed, as one patient refused operation, three had doubtful light perception and four showed massive vitreous retraction. Twelve eyes were operated on, and reattachment occurred in nine, or 75 per cent. In many cases in which no signs of inflammation were observed, the patients were older, and rather extensive degenerative changes were present. These two factors were possibly responsible for the poorer results in cases in which the inflammatory origin of the detachment could not be established.

This survey would not be complete without mention of the occurrence of glaucoma in 14 cases, or 16 per cent. In four cases the glaucoma was probably a direct

11. Schepens, C. L.: (*a*) XVI Concilium Ophtalmologicum, London, 1950, to be published; (*b*) Bull. et mém. Soc. franç. d'opht. 1950, to be published.

result of the surgical procedure, as in two instances vitreous filled the anterior chamber, and in two others the retinopexy caused a large hemorrhage in the vitreous, followed by glaucoma and loss of light perception. In the fifth case the lens was intumescent, and in the sixth there was a hypertensive uveitis in the active stage. In the eight remaining cases (9 per cent) we found deep chamber glaucomas which we were unable to explain. Glaucoma was bilateral in three cases. Such a high incidence of apparently unexplained glaucoma in cases of detachment and aphakia deserves closer investigation, as deep chamber glaucoma is not rare in phakic patients with detachment, particularly when there are lesions in the region of the ora serrata. The most logical explanation seems to be that the changes near the ora are the cause of both the detachment and the deep chamber glaucoma. This view is further substantiated by the fact that in another series, of 49 cases, with disseminated peripheral uveitis,[11a] deep chamber glaucoma was present five times (10 per cent).

Results of Retinopexy in Aphakic Eyes.—Few statistics are available on operative results in cases of detachment with aphakia. The consensus seems to be, however, that the prognosis in such cases is poor. Dunnington and Macnie [12] reported reattachment in two of 13 cases (15.4 per cent) as a result of operation. Shapland [5] reported reattachment in three of 43 eyes operated on (7 per cent). It is to be noted that his series was one of unfavorable cases—15 detachments after discission of the lens and 28 after extracapsular cataract extraction. Bagley [4] reported 35 per cent of reattachments. Berens, Hall, Smith and McAlpine [13] reported good results in 18 per cent. Leopold, in his discussion on Pischel's paper,[8] reported reattachments in two of eight cases after operation. Woodruff [14] noted that retinal detachment following cataract extraction was, for the most part, incurable.

From a therapeutic point of view, we have divided our cases into four classes (table 7). The first class consists of eight cases in which the eyes had only bare light perception or in which operation was refused. The second class consists of 11 cases in which no operation was advised because of the presence of massive vitreous retraction or large isolated fixed folds. Operation in such cases is almost always unsuccessful.

The third class contains cases in which surgical treatment was attempted in spite of the presence of visible vitreous retraction, as well as cases in which massive vitreous retraction occurred postoperatively. Of the 29 cases in the third class, we had reattachments in only 6 (20 per cent). In 12 cases there was massive vitreous retraction or large fixed folds before the operation. Nevertheless, there was one successful retinopexy in this group. This unexpected improvement is explained by the fact that the vitreous retraction was limited to the extreme periphery and did not affect the fundus posterior to the equator. Of 10 cases with small and localized fixed folds, reattachment occurred in five. Our impression is that even when the operation is successful, eyes with small fixed folds regain less

12. Dunnington, J. H., and Macnie, J. P.: Tr. Am. Ophth. Soc. **35**:101-125, 1937.

13. Berens, C.; Hall, D. S.; Smith, B., and McAlpine, P. T.: Surg., Gynec. & Obst. **70**: 454-465, 1940.

14. Woodruff, H. W.: Am. J. Ophth. **19**:146-150, 1936.

visual acuity and field than those without fixed folds. Postoperative massive vitreous retraction occurred in seven eyes; this complication cannot, so far as we now know, be predicted or prevented.

The fourth class consists of 40 cases without fixed folds, in all of which surgical treatment was attempted. Reattachment occurred in 33 cases, or 82.5 per cent. Failures comprise four cases in which reoperation was refused, two cases of vitreous hemorrhage and one case of unexplained failure.

Of the 69 eyes in classes 3 and 4, in which surgical treatment was attempted, reattachment occurred in 39, or 56.5 per cent. After elimination of cases in which failure was certain because of massive vitreous retraction or large fixed folds and cases in which reoperation was refused, there are 39 reattachments (72 per cent) and 15 failures. If, similarly, desperate cases are eliminated from a series of 137 consecutive operations for detachment in phakic patients, the percentage of reattachments is 80 per cent. Consequently, the percentages of reattachment in

TABLE 7.—*Results of Operation for Reattachment in Eighty-Eight Aphakic Eyes*

	No Operation	Failure	Reattachment	Total
Class 1				
Bare light perception or operation refused	8	..	..	8
Class 2				
No operation advised	11	..	..	11
Class 3				
Massive vitreous retraction or large fixed folds	..	11	1	12
Small fixed folds	..	5	5	10
Postoperative massive vitreous retraction	..	7	0	7
Class 4				
Reoperation refused	..	4	..	4
Postoperative vitreous hemorrhage	..	2	..	2
Unexplained failure	..	1	..	1
Reattachment	..	..	33	33
Total	19	30	39	88

aphakic patients (72 per cent) and in phakic patients (80 per cent) are remarkably close to each other, provided that one eliminates cases with massive vitreous retraction. It seems, therefore, that the poorer prognosis for aphakic patients resulted chiefly from the greater frequency of vitreous retraction. Another factor which strongly influences the results of retinopexy in cases of aphakia is the difficulty sometimes encountered in examining the periphery of the fundus, particularly after extracapsular extraction and after discission of the lens in young patients.

COMMENT

In 65 per cent of detachments with aphakia lesions occurred in the region of the ora serrata only, whereas in most cases of detachment in phakic patients changes appeared at the equator. Myopia, though still probably a factor, was less frequent with detachments in aphakic eyes than with detachments in phakic eyes. Retinal breaks were usually multiple and located in the extreme periphery of the fundus. The majority of them could not be seen with direct ophthalmoscopy. Subclinical detachments were probably more frequent, in the cases of detachment due to changes near the ora, than has hitherto been realized. Vitreous retraction, which affected the prognosis more than any other factor, was present in 45 per cent of our cases. Massive vitreous retraction made the surgical prognosis hopeless and was over

three times as frequent in aphakic as in phakic eyes. It occurred more frequently in patients under 50 years of age, regardless of whether or not they were aphakic. Other factors influencing the appearance of massive vitreous retraction were loss of vitreous, the long duration of the detachment and, perhaps, alterations near the ora serrata. In the majority of our cases posterior cortical opacities were present in the lens.

In about 40 per cent of the cases the first symptoms of detachment were observed within 12 months after the cataract extraction. In 21.5 per cent the detachment began before the cataract was extracted. In several additional cases a subclinical detachment was probably present before the extraction and developed insidiously after removal of the cataract. Results seemed poorer after extracapsular extraction and after discission of the lens in young patients than after intracapsular cataract extraction. We ascribe this difference to the difficulty of a good preoperative examination. Loss of vitreous was not a cause of detachment, but it made the prognosis poor. Incarceration of the iris seemed to have no influence. Signs of uveitis were present in 23 per cent of our cases, but the prognosis in these cases was remarkably good. Deep chamber glaucoma was not rare.

Reattachment occurred in 56.5 per cent of 69 eyes operated on. Of 55 eyes operated on by an intracapsular procedure, retinopexy resulted in reattachment in 62 per cent. Our fairly good results probably depend on a more adequate method of preoperative examination. Three factors might contribute to further improvement of the results; namely, earlier diagnosis of subclinical detachments, a procedure of cataract extraction which would facilitate examination of the extreme periphery of the fundus and extreme care in avoiding loss of vitreous in cases in which a detachment is likely to develop later.

In order to detect more cases of subclinical retinal detachment, should one examine the periphery of the fundus of every aphakic patient, or even of every patient with progressive lenticular changes? Such a procedure would certainly be tedious. In many cases the results would be negative, because retinal detachment seems to occur in only 1 to 2 per cent of all cases of cataract extraction.[15] It is important, therefore, to note any signs which may indicate that a detachment is to be feared in aphakic patients or in patients with changes in the lens. Progressive posterior cortical or posterior subcapsular opacities of the lens are very suggestive. If the patient has axial myopia as well, a detachment is to be feared still more, although myopia is of less importance than in aphakic subjects. If the patient complains of some of the subjective symptoms which often precede the occurrence of a detachment, his fundus should be examined at fairly short intervals. The presence of vitreous opacities is reason for suspicion in two groups of cases. In the first group, a fine, dustlike vitreous haze is observed in the extreme periphery; it often results from peripheral disseminated uveitis.[11] In the second group there is a sudden appearance or a sudden increase of peripheral and fairly coarse vitreous floaters, which may or may not be due to bleeding. Whenever mild uveitis is present, without visible foci either in the anterior segment or in the choroid posterior to the equator,

15. Berens, C., and Bogart. D.: Certain Postoperative Complications of Cataract Operations, with Particular Reference to Study of 1,001 Operations, Tr. Sect. Ophth., A. M. A., 1938, pp. 238-283. Schiff-Wertheimer, S., and Sédan, J.: Ann. d'ocul. **180**:513-520, 1947. Shapland.[6]

one should suspect an inflammation in the region of the ora. If examination of the extreme periphery confirms this suspicion, a detachment is to be feared. In certain cases of deep chamber glaucoma, a detachment may also occur, particularly if the eye shows a fine haze in the extreme periphery of the vitreous or mild signs of uveitis.

When there is reason to fear occurrence of a detachment, a few points concerning cataract surgery are worthy of consideration. The method of choice is probably an intracapsular extraction with complete iridectomy. This procedure will greatly facilitate examination of the fundus before, during and after the retinopexy. Loss of vitreous is undesirable because massive vitreous extraction seems to have a greater tendency to develop with detachments occurring after vitreous has been lost. As patients under 50 years of age also show a tendency toward vitreous retraction, loss of vitreous in young patients is particularly dangerous.

It is probably true that, in the experience of most surgeons who have not performed a large number of cataract extractions, the intracapsular procedure is oftener accompanied with loss of vitreous than is the extracapsular procedure. In a statistical study of loss of vitreous in cataract extractions performed at the Massachusetts Eye and Ear Infirmary between 1915 and 1925, Dunphy [16] reported loss of vitreous in 18.8 per cent of 441 intracapsular cataract extractions and in only 8.3 per cent of 1,821 extracapsular extractions. Consequently, for surgeons who do not have an exceptionally large experience with intracapsular extractions it may be wiser not to attempt extraction by this procedure in cases in which subsequent retinal detachment is likely and loss of vitreous is probable. In such cases it may be safer to perform, deliberately, an extracapsular extraction. If this method is used, it seems important to make a complete iridectomy, to remove a large piece of the anterior capsule and to evacuate the lens matter as well as possible. With this type of extracapsular extraction some of the difficulties encountered in examination of the fundus after extracapsular extraction would probably be avoided. When a membrane forms after operation and capsulotomy is indicated, one should be content with a small opening in the posterior capsule.

According to Shapland,[5] discission of the intact lens in young patients is followed by retinal detachment in 10.7 per cent of cases, whereas detachment after extracapsular extraction in adults occurs in only 2.2 per cent. Discission is particularly dangerous when it involves deep cuts into the vitreous. Therefore, when the lens does not absorb readily after the first discission, it seems preferable to perform a linear extraction with complete iridectomy, rather than repeated discissions. In many cases a full pupillary dilation cannot be obtained after discission of the lens and absorption of the lens matter. This condition renders ophthalmoscopic study of the periphery extremely difficult. For this reason, we favor the procedure of linear extraction with iridectomy, except when there is a specific contraindication. In young patients with bilateral congenital cataracts, it may be well not to operate on the second eye as long as visual acuity in the first eye is satisfactory, for hopeless bilateral detachments are not rare after bilateral discissions. The detachment may occur many years later, the average

16. Dunphy, E. B.: Loss of Vitreous in Cataract Extraction, J. A. M. A. **89**:2254-2257 (Dec. 31) 1927.

interval in Shapland's [5] 22 cases being 24.6 years. It is not known just what role is played by the discission in the causation of the detachment, but it is probable that it has at least some influence. Therefore, when the eye operated on is fairly good, it may be preferable to leave the fellow eye alone, for a detachment may develop in the eye operated on and retinopexy may fail. If this happens, the second eye may then be operated on for cataract, with a fair chance that no detachment will occur for many years.

Synthesis of the data collected in cases of retinal detachment with aphakia gives the picture of a clinical entity, which differs in several ways from the detachments generally seen in phakic patients. The principal cause of the disease is probably in the region of the ora serrata. In some cases there has been a chronic inflammation of this region, but in others one cannot determine whether the process was inflammatory or degenerative. This insidiously progressive disease of the extreme periphery is generally asymptomatic for a long period, but may eventually cause one or several of the following conditions: retinal detachment, posterior cortical cataract, deep chamber glaucoma and mild uveitis. We have observed several cases in which the syndrome was complete, and sometimes even bilateral, before the lens was extracted. In our opinion, therefore, detachment in aphakic patients is not generally the result of cataract extraction. The extraction is merely a complicating factor, which may, in cases in which the ora region is inflamed or degenerated, precipitate the course of a slowly progressive detachment. Its influence is perhaps comparable to a slight trauma which precipitates the development of a detachment in a myopic eye.

A number of cases with typical symptoms of this clinical entity have not been included in our statistics because the lens had not been extracted. The patients, nevertheless, had the same syndrome which affected most of our aphakic patients with detachment. On the other hand, a few of the aphakic patients in our series were not affected by the syndrome. They merely had equatorial changes which produced a detachment, and in them there developed a cataract of a common type, either cortical wedge-shaped opacities or nuclear sclerosis.

SUMMARY

During 1948 and 1949, 23 per cent (88 cases) of the total number of detachments treated in the Retina Service of the Massachusetts Eye and Ear Infirmary occurred in aphakic patients. The symptoms in the greater number of these cases differed from those of ordinary idiopathic detachments. These cases represent a clinical entity in which the disease is probably caused by an inflammation or a degeneration in the region of the ora serrata. The lesions near the ora are often asymptomatic for a long time but may eventually cause one or several of the following conditions: mild uveitis without visible foci either in the anterior segment or in the choroid posterior to the equator, posterior cortical opacities in the lens, retinal detachment and deep chamber glaucoma.

Detachment due to changes near the ora serrata, and without any equatorial lesions, was observed in 66 per cent of the cases with aphakia. In these cases, retinal breaks were multiple and extremely peripheral, and subclinical detachments were not rare.

In detachments associated with aphakia, vitreous retraction was present oftener than in idiopathic detachments.

An uncomplicated cataract extraction seemed to be no more than a precipitating factor in the causation of retinal detachment. The prognosis was poorer in young aphakic patients, after loss of vitreous, after extracapsular cataract extraction and, perhaps, after discission of the intact lens. Uveitis did not seem to affect the prognosis adversely.

Of 69 cases, retinopexy was successful in 56.5 per cent. Our results were better after intracapsular extraction; of 55 eyes operated on by this method, reattachment was observed in 62 per cent. These comparatively favorable percentages of reattachment probably depend on a more adequate preoperative method of examination. It is likely that these results could be improved on by an earlier and more frequent diagnosis of subclinical detachments and by the use of methods of cataract operation which would permit better visualization of the fundus periphery.

The Board of Surgeons, Massachusetts Eye and Ear Infirmary, made it possible to carry out this work.

ABSTRACT OF DISCUSSION

Dr. Everett L. Goar, Houston, Texas: This paper by Dr. Schepens opens a new era in the surgical treatment of retinal detachments. When a service is able to report 56.5 per cent of successful reattachments in an unselected series of aphakic eyes and a still higher percentage in cases in which massive vitreous retraction was eliminated, it is time that the rest of us learned something about its methods. My experience has been limited and rather disappointing. I have performed eight operations on seven aphakic eyes and have secured successful reattachments in only two. In neither of these has the postoperative period been a year; so there is always the possibility that the detachment will recur. Most clinics report successes in from 10 to 35 per cent of cases. It is evident, then, that Dr. Schepens and the Retina Service of the Massachusetts Eye and Ear Infirmary have something the rest of us do not possess. This is doubtless Dr. Schepens' method of indirect ophthalmoscopy, by which he finds retinal holes that cannot be seen by the direct method. His technic of indirect ophthalmoscopy must be difficult to master. I should like to have him explain how he is sure that the vitreous is retracted when he finds the signs he has enumerated. With the slit lamp and a contact lens or with the Goldman biomicroscope and a preset lens, it might be possible to see the hyaloid membrane posteriorly, but I do not know whether this has been accomplished. Dr. Chandler told me a few months ago that Dr. Schepens finds the holes, or "breaks," as he prefers to call them and tells the surgeon where to seal them. This is an ideal combination, and it must mean the difference between success and failure. I trust Dr. Schepens will teach others of us ophthalmologists to perform this examination, so that we may bring up our percentage of successes and so that we may urge patients to have the operation, rather than be forced to paint the dismal picture most of us have to today. I agree with Dr. Schepens that removal of a cataract has little to do with retinal detachment except in the case of loss of vitreous. Another predisposing factor, however, is discission of a secondary membrane. When the membrane is split by the discission knife, it comes forward into the anterior chamber, and the hyaloid membrane is always cut. I have seen retinal detachment follow this maneuver within 48 hours.

Dr. Schepens' paper is a valuable contribution to ophthalmologic literature.

DR. M. HAYWARD POST, St. Louis: Dr. Schepens has elaborated elsewhere a method of indirect ophthalmoscopy used in cruder form for many years, by means of which it is possible to visualize the region of the ora serrata with remarkable clarity. A magnification of only 2.2 times is obtained in the manner described and has proved far more satisfactory for this type of examination than the much greater magnification, 15 times, obtained with direct ophthalmoscopy. In an unpublished paper, Dr. Schepens reports that in a series of 400 successive patients with retinal detachment examined in the Retina Clinic, retinal tears were found by direct ophthalmoscopy in 41 per cent, by standard indirect ophthalmoscopy in an additional 23 per cent, and by his method in still 35 per cent more, leaving only 1 per cent, or four eyes, in which no retinal tears could be found.

Of especial interest are Dr. Schepens' comments on the advantages of this method of study with respect to detachments in aphakic eyes, referable to the fact that detachment in aphakia arises in a large percentage of eyes in the region of the ora serrata, where the method is particularly applicable. Certainly, the 56.5 per cent of reattachments in his classes 3 and 4 appear to substantiate the value of the method in the observation of detachments arising in this region.

Dr. Schepens' discussion of so-called massive vitreous retraction is of immense interest, and the importance of detection of this complication in determining the suitability of cases for operation, as well as the type of operation indicated, is obvious. Whether the process is essentially a shrinking of the vitreous or, as Dr. Pischel has suggested, a contraction of the retina or both, it is generally agreed that retinopexy is almost useless in such cases and that other methods of operation must be resorted to.

It is unfortunate that Dr. Schepens' figures on the frequency of detachments following the various types of cataract extraction are not more convincing. The small number of extracapsular extractions hardly justifies one's drawing conclusions with regard to the relative frequency of such complications in the two major methods of extraction. Further comment on the relative results in the sliding, or Verhoeff method and in the tumbling method would also be of value. I should like to add that the pressure was tried on my own eye, and I did not find it unpleasant in the least.

Figures obtained from the clinic at Washington University School of Medicine are about in accord with the usual run of such statistics, except for those reported in this paper.

DR. CHARLES L. SCHEPENS, Boston: I do not know what the relation of massive vitreous retraction is to detachment of the vitreous. It seems to me that in almost every case of massive vitreous retraction the hyaloid membrane was in contact with the retina. Unfortunately, the vitreous is often hazy in cases of massive vitreous retraction; consequently, observation of its posterior part is extremely difficult.

Dr. Goar is right when he insists on the danger of too liberal a discission of the membrane after an extracapsular cataract extraction.

It is extremely difficult to determine the value of light flashes as a symptom of early detachment. In many cases of light flashes, the fundus appears completely normal, even in the extreme periphery. In two such cases, however, a detachment occurred three weeks after a thorough examination of the region of the ora serrata revealed nothing abnormal. Another confusing fact is that a number of patients who were successfully operated on for retinal detachment still complain of flashes of light after many months, even though the retina is reattached everywhere and remains in situ.

In cases of massive vitreous retraction I have tried scleral resections, without success. It is probable that no surgical procedure can remedy the situation created by massive vitreous retraction. This does not mean that scleral resections should never be performed. It simply means that they are not the answer in cases of massive vitreous retraction.

RETINAL CORRESPONDENCE IN PATIENTS WITH SMALL DEGREE STRABISMUS

ARTHUR JAMPOLSKY, M.D.
SAN FRANCISCO

THE RELATIONSHIP of anomalous retinal correspondence, angle of strabismus and amblyopia is confused in the literature. It is stated (Adler and Jackson [1]; Travers [2]) that the incidence of anomalous correspondence increases as the angle of strabismus becomes greater and that anomalous correspondence is seldom found in esotropia of less than 15 Δ. Thus, a detailed study of patients with small angle esotropia is interesting from a theoretical and practical standpoint, because the correct sensorial relationships are difficult to evaluate and consequently lead to many erroneous conclusions. It is the purpose of this article to point out some of these errors in interpreting the sensorial relationships found in cases of small angle esotropia and to compare these conditions with those found in cases with which they are often confused.

One notes in figure 1 that Adler and Jackson [1] found a sharp decrease in the percentage of cases with anomalous correspondence when the angle of strabismus was below 15 degrees (approximately 30 Δ). The presence of anomalous correspondence was ascertained on a major amblyoscope. This finding is in direct contrast to the results obtained on patients with small angle esotropia to be discussed in this paper.

The term "small angle esotropia" will be used to refer to an angle of esotropia of less than 15 Δ, to which this study is confined. It is in cases of this type that most of the confusion exists relative to the interpretation of sensorial relationships and to the methods of treatment. The common reason for this is that the correct sensorial conditions in these cases of small angle strabismus can be ascertained only if the tests are so designed as to detect a small angle of anomaly. This study has revealed the specific characteristics of the small angle esotropia: 1. The angle of strabismus is less than 15 Δ and relatively constant. 2. The strabismus is monocular in type. 3. Anomalous retinal correspondence, usually of the unharmonious type, occurs in over 90 per cent of the cases. 4. There is a slight amblyopia of the

From the Division of Ophthalmology, Department of Surgery, Stanford University School of Medicine.

Read before the Section on Ophthalmology at the Ninety-Ninth Annual Session of the American Medical Association, San Francisco, June 30, 1950.

1. Adler, F. H., and Jackson, F. H.: Correlations Between Sensory and Motor Disturbances in Convergent Squint, Arch. Ophth. **38**:289 (Sept.) 1947.

2. Travers, T. âB.: Suppression of Vision in Squint and Its Association with Retinal Correspondence and Amblyopia, Brit. J. Ophth. **22**:577, 1938.

deviating eye. 5. There is a high incidence of anomalous peripheral apparent "fusion." 6. There is an area of foveal or macular suppression of the deviating eye.

Two typical case histories are presented, each illustrating different salient points.

CASE 1.—Mr. R. C., aged 45, had onset of esotropia of the right eye at the age of 3 years. Corrected vision was 20/50 in the right eye and 20/20 in the left eye. The right eye was esotropic 10 △, as determined by the intermittent monocular cover test. (An angle of strabismus of 2 or 3 △ may be accurately determined by this test.) When the right eye was covered, neither eye moved. When the left eye was covered, there was a conjugate movement to the right of 10 △, and when the cover was removed, there was a conjugate movement to the left of 10 △. Harmonious anomalous correspondence was found if the left eye was fixing, and normal correspondence if the right eye was made to fix, when the patient was examined with the red glass double image test, the Maddox rod test or the Tschermak congruence apparatus. On the major amblyoscope an objective angle of 12 △ of convergence was found, and the subjective angle was zero. When moderate-sized similar targets were placed in the major amblyoscope

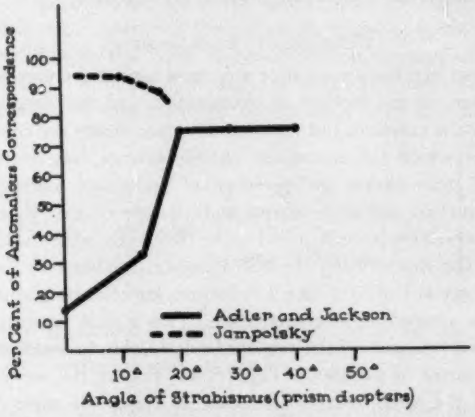


Fig. 1.—Relationship of angle of strabismus to type of correspondence as determined by Adler and Jackson[1] (solid line). The dotted line shows this relationship in small angle esotropia, as found in the present study.

at zero angle (troposcope), there was anomalous "fusion" with paramacular check marks described correctly. Some amplitude of fusion with a small area of central suppression was demonstrated.

This case shows that in the presence of the harmonious type of anomalous correspondence some amplitude of fusion frequently can be demonstrated. This has been well recognized for some time in cases of larger degrees of strabismus with harmonious correspondence and occasional anomalous fusion in which base-out prism is overcome in the same manner as by an orthophoric patient.[2a] These smaller degrees of strabismus are similar but are frequently confused because of their apparent fusion with similar targets and the difficulty in measuring anomalous correspondence in such small degrees. The difference is a matter of magnitude

2a. Travers.[2] Burian, H. M.: Sensorial Retinal Relationship in Concomitant Strabismus, Tr. Am. Ophth. Soc. **43**:373, 1945; Fusional Movements in Permanent Strabismus: Study of Role of Central and Peripheral Retinal Region in Act of Binocular Vision in Squint, Arch. Ophth. **26**:626 (Oct.) 1941.

alone. It is usual, however, to find the unharmonious type of anomalous correspondence in cases of esotropia of less than 15 △, in which one can less frequently demonstrate anomalous fusional amplitudes, even though in many of them there is anomalous fusion in the squinting position. The following case is an example.

CASE 2.—D. M., a boy aged 7 years, had onset of strabismus at the age of 2 years. A constant left esotropia of 12 △ was found. When the left eye was covered or uncovered, neither eye moved. When the right eye was covered, there was a conjugate movement to the left of 12 △. When the right eye was uncovered, there was a conjugate movement to the right of 12 △. A prism of up to 4 D. base out before the left eye did not elicit diplopia and did not cause any fusional movements. Any amount of base-out prism before the right eye caused a conjugate movement to the left. The red glass diplopia test, the Maddox rod test, the Tschermak congruence apparatus and the major amblyoscope all showed anomalous correspondence of the unharmonious type. On the major amblyoscope, the objective angle measured 15 △ of convergence, and the subjective angle, 5 △ of convergence. There were diplopia at the objective angle with similar haploscopic targets and peripheral fusion at O ± 5 △.

METHODS OF MEASUREMENT

Whether or not one finds normal or abnormal retinal correspondence in a given case depends often on the method of examination and the sensitivity of the test. The more closely the conditions of the method approximate the conditions of casual seeing habits, for which the anomalous correspondence was developed, the more likely one is to demonstrate the presence of anomalous correspondence. This criterion is best met by use of the major amblyoscope or the projection apparatus, and anomalous correspondence is found more frequently with these tests than with other methods. The more closely the test simulates a laboratory experiment wanting in everyday visual cues (so-called reduction experiments), the less likely one is to demonstrate anomalous correspondence. This is best illustrated by the after-image test. In measurement of the sensorial relationship in small angle strabismus, there is another factor of paramount importance; that is, the sensitivity of the test used must be of the same order of accuracy as the small angle one is trying to measure. The after-image test is not satisfactory for the usual young child with strabismus if one is attempting to detect an angle of anomaly as small as a few prism diopters, for the child usually describes a cross if the after-image closely approximates this. Older children and adults with a small degree of strabismus may accurately determine the angle of anomaly of a few prism diopters by the after-images.

Dissimilar haploscopic targets of the usual size used for detection of anomalous correspondence are too gross for the detection of a small angle of anomaly. The lion or bird will be said to be in the cage with moderate-sized or large targets if the greater part of one is superimposed on the other. Small targets must be used or larger ones so designed that one may detect differences of a few prism diopters. Some observers object to the use of small targets because of the variability in deviation usually found in strabismus, making such tests inaccurate. In the small angle esotropia, nonvariability is a characteristic, and repeatable measurements may be made. Different types of paramacular targets, designed so as to be independent of suppression areas, were also used in this study. The data for figure 1 were obtained by measurements made on the major amblyoscope (troposcope). The presence of

anomalous correspondence in these cases was also corroborated by the red glass diplopia test, the Maddox rod test, and the Chavasse modification [3] of the Tschermak congruence apparatus.

That the anomalous retinal correspondence found with these tests on the major amblyoscope in cases of small angle esotropia is not merely a product of a particular method of measurement is made clear by a comparison of the findings in the same tests on normal, orthophoric patients and on patients with all degrees of esophoria with and without suppression.

In normal, orthophoric patients, when the amblyoscope tubes are set at the objective angle, with the dissimilar targets shown in figure 2, the central dot appears in the center of the box, circle or line steadily, without rivalry. This may be done with repeatable accuracy, showing normal retinal correspondence. Likewise, patients with esophorias with and without suppression will give similar responses when the amblyoscope tubes are set at the objective angle. On the other hand, in patients with small angle esotropias the subjective angle does not equal the objective angle measured with the same targets, showing anomalous correspondence. With the targets shown in figure 2, an angle of strabismus and an angle of anomaly of a few prism diopters can easily be determined. Ninety-two per cent of 84

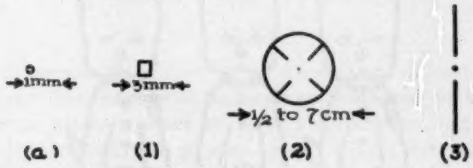


Fig. 2.—Dissimilar targets used in testing patients with small angle esotropia on the major amblyoscope. Both macular to macular and macular to paramacular correspondence may be tested, with absence of overlapping marks of any sort.

patients in this series had anomalous correspondence as measured on the major amblyoscope with the method described. Notable exceptions were patients with deep amblyopia and normal retinal correspondence prior to operation who showed improvement to a small degree of esotropia after operation with maintenance of both normal correspondence and amblyopia.

COMPARISON OF FUSION STATUS

Patients with a small degree of esotropia demonstrable by cover test often appear to fuse with routine stereoscopic and amblyoscopic targets. They do so with the visual axes in the strabismic position. This is an anomalous correspondence fusion with macular or paramacular areas. Because of this apparent fusion, the condition is frequently misinterpreted as a poor quality of normal retinal correspondence fusion, although it is well known that the type of correspondence cannot be ascertained from similar fusionable targets.

The apparent fusion shown in these small angle esotropias has often been confused and misinterpreted as being esophorias with normal correspondence with a

3. Chavasse, B.: Tests for Secondary Correspondence in Squint, Tr. Ophth. Soc. U. Kingdom **55**:482, 1935.

retinal slip or fixation disparity (Pugh [4]; Kirschberg [5]). The apparent fusion of patients with a small degree of esotropia may be clearly differentiated from an esophoria with retinal slip. Patients with esophoria and retinal slip show a true phoria response with the intermittent monocular cover test, as would be expected. It has been shown that the amount of retinal slip allowable is indeed small.[6] With the cover test or on the major amblyoscope it is seen that the esophoric patient maintains his visual axes straight while fusing, but the esotropic patient "fuses" with one visual axis in the deviating position. This can always be demonstrated. Patients with esophoria and retinal slip all show normal correspondence with the dissimilar targets in the tests outlined previously.

With the fusional targets (fig. 3) set at the straight-ahead position on the major amblyoscope (zero angle), patients with esophoria and retinal slip fuse and describe all peripheral check marks correctly but see only one or two dots centrally, showing suppression in the central area. This is probably due to the fact that in this zone Panum's areas of single binocular vision are smaller than at the periphery, where a larger slip may occur before diplopia is elicited. Therefore, suppression will occur first in the central areas, where the diplopia first occurs. It is significant,

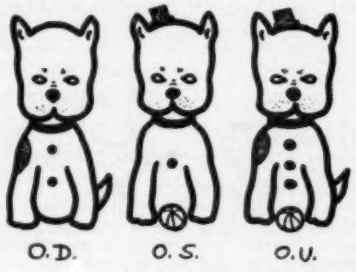


Fig. 3.—Similar fusion targets used in these experiments. There are both central and peripheral nonoverlapping check marks and a common point (the nose) for fixation.

however, that if the esophoria is then allowed to become manifest by moving the amblyoscope tubes to the fusion-free position (the objective angle or position of rest) the patient will usually see all three central dots simultaneously and in line. In this position one has eliminated the retinal slip and the suppression adapted to it.

On the other hand, no patient with esotropia, demonstrable by cover test, even of a few prism diopters, sees the three dots simultaneously in any position of the amblyoscope tubes. There is always some central suppression of the deviating eye, although the peripheral check marks are correctly described. Some esotropias have harmonious anomalous correspondence with a well developed anomalous fusion and some amplitudes of fusion, as was previously noted, but differ from the esophoria with normal correspondence and retinal slip in response to the dissimilar targets determining retinal correspondence and in the type of fusion with similar targets.

4. Pugh, M. A.: Squint Training, New York, Oxford University Press, 1936, p. 81.

5. Kirschberg, L. S. S.: Detection of Abnormal Retinal Correspondence, Tr. Canad. Ophth. Soc. 1948, p. 103.

6. Ogle, K. N.; Mussey, F., and Prangen, A. de H.: Fixation Disparity and the Fusional Processes in Binocular Single Vision, Am. J. Ophth. **32**:1069, 1949.

ETIOLOGY

Cases of small degree esotropia may occur (1) naturally; (2) in association with a corrected hypermetropic refractive error, or (3) as a postoperative development. Cases in the last group represent the common cosmetic cures, in which a larger angle of esotropia is reduced surgically to a smaller angle of esotropia with establishment of a new small angle of anomaly.

Cases of small degree esotropia frequently arise as the result of the initial optical correction of a purely accommodative strabismus in which some degree of amblyopia may have developed prior to the optical correction. The dramatic cosmetic result with simple optical correction in these cases of purely accommodative strabismus overshadows the amblyopia which may be present, and which is an impediment to fusion. A small degree of esotropia may result. Whenever one changes the visual axes from a deviated to a straight position, one should attempt to have as nearly equal vision as possible at the time if fusion is to be expected. This rule is well recognized prior to the surgical straightening of the visual axes but is often overlooked in optical straightening. It is suggested that a short period of occlusion for the treatment of amblyopia coincident with the initial hypermetropic optical correction may mean the difference between a real normal correspondence fusion and a small angle esotropia with anomalous retinal correspondence and apparent fusion.

TREATMENT

Attempts to straighten the strabismus by orthoptic methods alone rarely, if ever, meet with success. The presence of an angle of strabismus or angle of anomaly of only a few prism diopters makes it almost impossible to convert the esotropia by orthoptic methods to normal correspondence with a fusional amplitude and straight eyes, because the amblyoscope targets used in the usual orthoptic methods must be so small as to make orthoptic treatment impractical. It should be recognized that, with infrequent exceptions, esotropia of less than 15 Δ demonstrable by cover test is incurable by orthoptic methods alone, and that the smaller the degree of strabismus, the more remote the possibility of cure. I have occasionally been able to reduce the angle of strabismus by alternating occlusion over a period of time sufficient to favor a more divergent position of the visual axes. Use of the patch is then discontinued, at which time there is the development of a new, smaller angle of strabismus and a new, smaller angle of anomaly and anomalous correspondence. In one such case, in which an original esotropia of 30 Δ had been surgically reduced to a constant esotropia of 15 Δ, the angle of strabismus was further reduced by this method of occlusion over a period of five months to a constant esotropia of 5 Δ. In this case, three different sets of subjective and objective angles and angle of anomaly were determined for the preoperative, postoperative and post-occlusion periods, respectively. Such a finding of three different sets of anomalous correspondence is good evidence, although not proof, that anomalous correspondence is a sensorial adaptation.

One not infrequently finds patients with small angle esotropia being treated orthoptically as having normal retinal correspondence with fusion. The apparent fusion found with similar targets is one of anomalous correspondence fusion, for which vigorous orthoptic treatment with fusion targets can only consolidate the anomalous correspondence when it goes unrecognized. Here one commits the same

error as with the old hand stereoscope method of treatment in cases of strabismus of a larger degree, in which anomalous correspondence is now more easily recognized.

Surgical treatment of such small angle strabismus is usually not indicated. If the degree approximates 15 Δ, and if, for some reason, surgical treatment is attempted, the best that one can usually obtain is a new, smaller angle of strabismus with establishment of a new anomalous retinal correspondence. The patient may retain the preoperative angle of anomaly if the strabismus is of long standing, or he may demonstrate both the preoperative and the postoperative angle of anomaly, depending on the method of measurement used.

In the practical treatment of this type of strabismus, the recognition of the sensorial relationships, as previously described, is important. If one wishes to discontinue the hypermetropic correction in eyes that are apparently fusing, either by gradually decreasing the correction or by orthoptic training, one may be successful if the patient is really fusing with normal correspondence. In cases of small angle esotropia with anomalous fusion in the slightly deviated position, there is not the "backstop of good fusion" that allows one to decrease the correction with an equal degree of success. "Almost straight" is usually not enough for development of stable fusion. The patient must actually fuse with normal correspondence for the procedure described to meet with any degree of success.

COMMENT

The purpose of this study is not to disclose a new clinical entity but, rather, to draw attention to a specific type of strabismus which is commonly misinterpreted and mistreated. Recognition of the peculiar characteristics are of practical clinical interest, and the theoretical implications help to elucidate the sensorial mechanism in strabismus.

The demonstration of over 90 per cent of anomalous correspondence in patients with esotropias of less than 15 Δ is at variance with previously held concepts regarding the incidence and relationship of anomalous retinal correspondence, amblyopia and angle of strabismus.

Patients with a very small degree of esotropia do not complain, for the most part, especially when the hypermetropic refractive error is not a factor. In this case the patient is usually comfortable, lacking a few of the advantages of full binocular vision and escaping some of the disadvantages. It should be remembered that normal retinal correspondence with full fusion is not synonymous with, nor a prerequisite of, comfortable binocular vision. The main disadvantages are the lack of true stereopsis and a very slight amblyopia of the slightly deviating eye. The patient is cosmetically satisfied and usually unaware of any abnormality unless rendered an ocular cripple by exaggerated awareness of the condition or by overly judicious treatment.

SUMMARY

This is a report of a detailed examination of patients with esotropia of less than 15 Δ. Of 84 patients, 92 per cent demonstrated anomalous retinal correspondence on the major amblyoscope when the conditions of testing were adapted to the measurement of the small degree of strabismus and the small angle of anomaly. That this finding is not an artefact or conditioned to the particular method of testing is shown by comparison of the results of the same tests on normal, orthophoric

patients and on patients with esophoria with and without suppression and retinal slip. This was checked by alternative methods of examination, such as the red glass diplopia test, the Maddox rod test, the Tschermak congruence apparatus or the after-image test.

The specific characteristics of the case of small angle esotropia are an angle of strabismus less than 15 Δ, which is constant and monocular, and a high incidence of anomalous retinal correspondence and anomalous peripheral fusion. There is also a slight amblyopia of the deviating eye with the foveal or macular suppression.

Such cases occur naturally, or as the result of an initial hypermetropic correction of a purely accommodative strabismus with amblyopia or as a postoperative development following the cosmetic correction of a larger degree of esotropia. With infrequent exceptions, orthoptic training fails in these cases. This point needs emphasis because one not infrequently finds orthoptic treatment instituted in cases with eyes "almost straight," in hope of a cure, when the sensorial conditions have been misinterpreted.

2400 Clay Street.

ABSTRACT OF DISCUSSION

Dr. George A. Filmer, Denver: Dr. Jampolsky's finding of a high incidence of anomalous retinal correspondence in cases of small angle strabismus by his more critical testing method is interesting and logical. Most of us find much the same behavior in our cases of the same category. My colleagues and I have presently under observation in the orthoptic clinic of the University of Colorado School of Medicine two patients with strabismus of this type—one each in two of the three groups noted in the paper. One has had a convergence of 7 degrees since infancy; the other's convergence, originally 30 degrees, has been reduced surgically to 8 degrees. Each patient has had a long series of orthoptic treatments, without real improvement; some effort at fusion of large targets has been noted, with obvious use of peripheral "fusion."

An interesting effect was noted in the child with convergence of 7 degrees of the left eye. Vision was 20/20 in the right eye and 20/30 in the left eye. After the orthoptic clinic had noted some apparent fusion of large objects, base-out prisms were given to encourage simultaneous macular perception. On examination later, he showed fully as much convergence with the prisms as he had previously shown without them. He had increased his convergence to use again his anomalous retinal correspondence while wearing the prisms.

It is certainly true that the results of orthoptic treatment are poor in cases of this type. I believe that in most cases it is the peripheral fusional effect which is stimuated, the central anomaly being unchanged. I think, too, that there are patients who can readjust the amount of their vergence while being treated on the instrument so as to use the anomalous retinal correspondence to which they have become accustomed. Thus, the orthoptic treatment would stimulate, rather than discourage, the central anomalous retinal correspondence. I agree with Dr. Jampolsky that to subject these patients to a prolonged course of orthoptic training is not justified, and may actually do psychic harm. Dr. Jampolsky has furnished a valuable point of information to the ophthalmologist in noting that an orthoptic report of "some effort at fusion of large targets" does not usually mean a true fusional effect, and does not constitute a good reason for indefinitely continuing orthoptic treatment.

Dr. Paul W. Miles, St. Louis: Horror fusionis is an ancient term which might apply to certain of these cases in which the angle of squint is small and the response to surgical correction or orthoptic training is poor.

I wish to cite two cases in which such a condition was treated by aniseikonic glasses with success. The first case was that of a South American who had undergone two surgical procedures and had had an unknown amount of orthoptic train-

ing in South America. He came to the Dartmouth Eye Institute, where examination by Dr. Bielchowsky and Professor Ames showed that he had a high amount of aniseikonia. This man's severe symptoms had been treated for several years without relief. Dr. Jampolsky mentioned that most of these patients have few symptoms or complaints. A patient with horror fusionis has tremendous complaints of headache and asthenopia. In this case of Bielchowsky's, the complaints were relieved by aniseikonic glasses.

A second case, which came under my charge, was similar. The patient, a young woman, had had two operations, one in Philadelphia and one in New York, and had had five years of orthoptic training. At the time she consulted me the patient was 22; she had internal strabismus of about 2 degrees and complained of tremendous discomfort. She was unable to do her work. She was found to have an over-all aniseikonia of about 4 per cent. By an indirect method of examination and after some trial and error over a period of three or four months, the patient was fitted with aniseikonic glasses. I heard from her a few weeks ago. She has been wearing refractive and aniseikonic correction for 3½ years and is entirely satisfied. At one interval during that time she went to a physician consulted previously who advised her to remove the aniseikonic correction to lighten the spectacles. This she did but immediately had a recurrence of her symptoms.

I should like to propose aniseikonic glasses as a method of improving fusion in a patient with small angle strabismus which is not improved surgically or by orthoptic training.

DR. ARTHUR JAMPOLSKY, San Francisco: Dr. Filmer mentioned a case in which the base-out prism was overcome after it had been worn a while, the patient being left with the same degree of esotropia. In my experience, this is found most commonly in patients with the harmonious type of retinal correspondence.

Dr. Miles mentioned horror fusionis in cases of small angle esotropia. This term has frequently been misused. Patients with true horror fusionis change the visual axes to avoid superimposition of similar targets on the maculas. They usually have normal retinal correspondence and are unable to suppress. This is most interesting and is related to the pathogenesis of anomalous retinal correspondence, in that anomalous correspondence follows in the wake of suppression necessary in eyes with equal vision and strabismus. The validity of that statement is now being investigated. We have not measured the aniseikonia in our cases of small angle esotropia.

NITROGEN FRACTIONS AS CRITERION OF PRESERVATION OF CORNEAL TISSUE

WILHELM BUSCHKE, M.D.†
AUDREY HOWARD, B.A.
AND
LUCY SIEGEL, B.A.
NEW YORK

QUANTITATIVE data on nonprotein nitrogen fractions in the tissue may be expected to furnish useful criteria for the state of preservation of corneal donor tissue stored under various conditions. The present report deals with data on total nonprotein nitrogen, ammonia nitrogen and amino nitrogen.

MATERIALS AND METHODS

The data were obtained from freshly excised corneas with and without incubation of the excised corneas in a moist chamber at 40 C. for six hours, and from corneas stored for three days in the whole eye in a moist chamber at 4 C. with and without subsequent incubation of the excised cornea in a moist chamber at 40 C. for six hours. Storage of the whole eye at 4 C. in a moist chamber is the most widely used method of storage of human corneas for clinical purposes. As previously reported,[1] the cornea becomes progressively hydrated under these conditions. It was of particular interest to see what changes in nitrogen fractions are observable under experimental conditions designed to imitate the in situ conditions of a cornea during the first few hours following the transplantation operation. The experiment with incubation of the corneas at higher temperature subsequent to cold storage was done with this point in mind. Storage procedures, other than storage of the cornea in the whole eye, included cold storage of excised corneas under liquid mineral oil petrolatum U. S. P. or in an atmosphere over 0.5 M. sodium chloride solution, i. e., under conditions excluding hydration.

Nitrogen determinations were carried out on pooled samples of three corneas each. The eyes were obtained from freshly killed cattle. Aseptic precautions and brief flushing of the eye with sterile saline solution were used in preparing the corneas in several experiments; the results were not significantly different from those in experiments in which clean instruments only were used. The corneas to be extracted were rapidly frozen between solid carbon dioxide

† Dr. Buschke died Dec. 21, 1950.

From the Ayer Foundation Ophthalmic Research Laboratory, Manhattan Eye, Ear and Throat Hospital.

Part of this paper was read at the meeting of the American Physiological Society, Sept. 15, 1950, Columbus, Ohio.

This work was supported in part by a cancer research grant of the National Cancer Institute, United States Public Health Service.

1. Buschke, W.: Studies on Experimental Corneal Storage: Bibliographic Survey; Observations on Water Uptake and Corneal Stroma Cells, Nineteenth Scientific Meeting, Association for Research in Ophthalmology, San Francisco, June 1950.

and dropped into ice-cold sulfuric acid (10 ml. N/6 sulfuric acid for three corneas), to which 1.25 ml. of 15 per cent sodium tungstate was added immediately. After standing overnight in the refrigerator, the corneas were cut into small pieces. Three pooled corneas thus treated with the deproteinizing agents, and minced for five minutes, were given into the mortar of the Fisher mortar grinder and ground with silica for one-half hour. The deproteinizing solution used for suspension was added in small portions. The suspension was then shaken for complete extraction on a gyrosolver for from one to five hours after two portions of 3 ml. each of N/6 sulfuric acid, with which the mortar had been washed, were added. The suspension was then filtered and made up to 15 ml. with the sulfuric acid solution. Nonprotein nitrogen was determined with the micro-Kjeldahl procedure of Borsook [2]; ammonia nitrogen, by the Conway microdiffusion method,[3] with subsequent nesslerization and colorimetric determination; amino nitrogen, with the ninhydrin method of Van Slyke and associates.[4]

RESULTS

The individual figures given in table 2 are experimental data obtained from three pooled corneas in each sample and are computed for single corneas. No further standards of reference (e. g., grams wet weight; grams dry weight; total nitrogen) were used. Preliminary experiments had shown a great consistency in

TABLE 1.—*Largest Diameters and Dry Weights of Beef Corneas*

	Largest Diameters (Arc) of Individual Corneas, Mm.	Dry Weights of Corneas (3 Pooled Corneas in Each Sample), Mg.
No. of samples	28	18.0
Minimum	33	87.0
Maximum	36	121.0
Mean	35	103.4
Standard deviation	1	9.7

size of the corneas taken at random. These preliminary data are summarized, with standard deviations, in table 1. It is apparent that the longest diameter of the beef cornea, as measured from limbus to limbus with a thread, showed extremely small variations. This may be taken to indicate that no extreme variations in the sizes occurred, and that therefore appreciable variations in the age of the animals were not likely to have occurred in our material. A somewhat larger variation was found in the dry weight, undoubtedly due largely to variations in the procedure of excising the corneas. However, even these variations were within moderate limits, the standard deviation being 9.4 per cent of the mean.

2. Borsook, H.: Micromethods for Determination of Ammonia, Urea, Total Nitrogen, Uric Acid, Creatinine (and Creatine), and Allantoin, J. Biol. Chem. **110**:481-493, 1935. Borsook, H., and Dubnoff, J. W.: Methods for the Determination of Submicro Quantities of Total Nitrogen, Ammonia, Amino Nitrogen, Amides, Peptides, Adenylic Acid, and Nitrates, ibid. **131**:163-176, 1939.

3. Conway, E. J., and Byrne, A.: An Absorption Apparatus for Micro-Determination of Certain Volatile Substances: I. Micro-Determination of Ammonia in Body Fluids, Biochem. J. **27**:419-429, 1933.

4. Van Slyke, D. D.; MacFadyen, D. A., and Hamilton, P.: Determination of Free Amino-Acids by Titration of the Carbon Dioxide Formed in the Reaction with Ninhydrin, J. Biol. Chem. **141**:671-680, 1941.

The data on nitrogen fractions are summarized in table 2. After cold storage, nonprotein nitrogen and ammonia nitrogen values were found to be only slightly higher than those for fresh corneas, and the differences were probably not significant. Likewise, freshly excised corneas incubated at 40 C. for six hours had nonprotein nitrogen and ammonia nitrogen values not significantly higher than did fresh control corneas. In contrast, significantly higher nonprotein nitrogen and ammonia nitrogen values were found for corneas which, after three days of cold storage in the whole eye in a moist chamber, had been incubated at 40 C. for six hours. In those experiments in which hydration of the tissue during cold

TABLE 2.—*Nitrogen Fractions in Beef Corneas, Expressed as Micrograms per Cornea* *

	Total Nonprotein Nitrogen	Ammonia Nitrogen	Amino Nitrogen
1. Fresh corneas	197 (11) 155 — 244 28	24.4 (16) 19.3 — 33.0 7.4	56 (7) 37.0 — 73.9 28
2. Corneas stored in whole eye at 4 C. for 3 days in moist chamber	227 (14) 163 — 310 53	29.2 (13) 17.8 — 38.8 7.4	52 (11) 33 — 73 36
3. Fresh excised corneas incubated at 40 C. for 6 hr.	213 (9) 157 — 281 48	32.4 (12) 22.8 — 41.0 5.1	45 (4) 28 — 72 51
4. Corneas stored in whole eye at 4 C. for 3 days in moist chamber, subsequently incubated at 40 C. for 6 hr.	321 (12) 246 — 431 53	37.7 (12) 25.8 — 56.8 8.4	59 (11) 38 — 79 37
5. Excised corneas stored in liquid petrolatum U. S. P. at 4 C. for 3 days	222 (3) 210 — 231 11	....	....
6. Excised corneas stored in liquid petrolatum at 4 C. for 3 days and subsequently incubated at 40 C. for 6 hr.	197 (6) 170 — 223 20	....	....
7. Excised corneas stored in an atmosphere over 0.5 Ml. NaCl at 4 C. for 3 days, and subsequently incubated at 40 C. for 6 hr.	233 (5) 156 — 273 43	33.9 (5) 31.3 — 38.3 2.6	....
8. Excised corneas incubated for 6 hr. at 40 C. after injection of M/200-M/50 NaF in M/7 NaCl	267 (13) 226 — 338 37	25.3 (3)	....
9. Excised corneas incubated for 6 hr. at 40 C. after injection of M/7 NaCl (control to experiment 8)	216 (13) 166 — 256 31	20.5 (2)	....

* Figures in row 1 of each experiment are mean values, with number of samples in parentheses; figures in row 2, the range of values, from minimum to maximum, and figures in row 3, the standard deviations.

storage was avoided, i. e., with storage under liquid petrolatum U. S. P. or in an atmosphere over a 0.5 M sodium chloride solution, no significant or considerably smaller increases in nonprotein nitrogen were found on subsequent incubation at 40 C. The amino nitrogen values fluctuated considerably under the various conditions, and no characteristic changes could be established for any one group.

Some fresh corneas were also incubated at 40 C. after injection of 0.75 ml. of sodium fluoride in concentrations of between M/200 and M/50, dissolved in M/7 sodium chloride solution. The previous observation by one of us (W. B.)[5]

5. Buschke, W.: Effects of Metabolic Poisons and of Some Other Agents on Intercellular Cohesion in Corneal Epithelium, Am. J. Ophth. **33**:59-68, 1950.

that fluoride interferes with intercellular cohesion in corneal epithelium on incubation suggested increased proteolysis under these conditions. Some increase in nonprotein nitrogen was found (experiment 8, table 2), as compared with corneas given injections of isotonic sodium chloride solution only (experiment 9, table 2).

COMMENT

Data on nonprotein nitrogen fractions in stored corneas, previously reported by Shesterikova and Gelelovich,[6] seemed to indicate increases in nonprotein nitrogen after a few days of cold storage of the cornea in the whole eye, even without subsequent incubation. Their data, however, show considerable scatter, and the significance of apparent mean increases may be questioned, at least for the first few days of storage. Our data on nitrogen fractions in fresh corneas incubated at higher temperature are in good agreement with those of Herrmann and Moses,[7] who likewise failed to find significant increases in fresh corneas incubated for several hours unless the tissue had been damaged (e. g., with nitrogen mustard [methyl-bis or tris-(2-chloroethyl) amine]) prior to incubation. Our data on fluoride-poisoned corneas provide an example of d nitrogen catabolism under the influence of a metabolic poison which also le to loss of cell cohesion.

The increase in nonprotein nitrogen in corneas incubated after cold storage in the whole eye, as reported here, raised an interesting question. Is it possible that the appearance of these chemical changes, with liberation of diffusible nitrogen substances, would provide steps in the mechanism of the clearing of clouded areas of the host cornea surrounding grafts from stored tissue, as reported by Filatov[8] and others and reviewed recently by Fine[9]? It should be stressed in this connection that all data reported here are indicative only of differences in chemical behavior between fresh corneas and those stored with various methods. While these data provide some criteria of tissue preservation, they do not answer the question whether or not fresh, well preserved tissue is the most favorable material for corneal grafting. An answer to the latter question can be expected only from grafting experiments with tissues of various different states of preservation. It is particularly of interest in this connection that we find no significant changes in nitrogen fractions in the tissue immediately following cold storage of the cornea in the whole eye. However, such tissue is susceptible to some chemical deterioration on incubation at higher temperature, i. e., under a condition which would prevail likewise after transplantation.

---

6. Shesterikova, F. P., and Gelelovich, E. I.: Dynamics of Biochemical Processes in the Cornea During Preservation: I. Changes in Nitrogen Products of the Cornea, Med. zhur. **10**:277-286, 1940.

7. Herrmann, H., and Moses, S. G.: Studies on Non-Protein Nitrogen in the Cornea, Bull. Johns Hopkins Hosp. **82**:295-311, 1948.

8. Filatov, V. P.: Optical Transplantation of the Cornea and Tissue Therapy, State Publication of Medical Literature (MEDGIZ), Moscow, 1945.

9. Fine, M.: Clearing Effect of Transplanted Cornea on the Opacity of the Recipient Cornea, Arch. Ophth. **43**:1065-1073 (June) 1950.

Our data suggest strongly that some correlation exists between hydration of the tissue during cold storage and susceptibility to processes of autolysis on subsequent incubation at higher temperature. It is conceivable that an increase in hydration favors nitrogen catabolism, at least under certain experimental conditions.

SUMMARY

Data on nonprotein nitrogen, ammonia nitrogen and amino nitrogen in stored beef corneas are reported.

1. Increases in total nonprotein nitrogen and ammonia nitrogen were found in corneas stored in the whole eye in the cold for three days, on subsequent incubation of the excised cornea at higher temperature.

2. Fresh corneas or corneas stored under conditions excluding hydration showed no, or less, significant increases in nitrogen fractions on subsequent incubation.

3. An increase in nonprotein nitrogen was found also on incubation of fresh corneas given injections of M/200 to M/50 sodium fluoride.

The observations are discussed with respect to their possible biologic significance.

GREATER SUPERFICIAL PETROSAL NEURECTOMY FOR RELIEF OF CHRONIC BULLOUS KERATITIS

LORAND V. JOHNSON, M.D.
AND
WILLIAM A. NOSIK, M.D.
CLEVELAND

COGAN [1] has done much to clarify knowledge of the circulation of fluid from the limbus through the stroma. The schematic drawing (fig. 1) illustrates his theory of fluid movement through the cornea. Figure 2 indicates his inability to produce bullous keratitis by forcing fluid into the cornea from the aqueous. He was able to produce typical bullous keratitis only by the absorption of fluid from the outside through the hypertonicity of the cornea, the symbols —, + or +, + + representing the artificially produced osmotic relations. He found (fig. 3) that the epithelium and endothelium are impermeable to sodium chloride and thus act as a semipermeable membrane, and that the stroma is permeable to sodium chloride and consequently is unable to act as a semipermeable membrane. Water thus remains, to produce bullous keratitis, because there is no further osmotic pressure to transfer the water through the stroma. His experiments showed that electrolytes, such as sodium chloride, were excluded from the cornea by the epithelium and endothelium, the experiments being carried out with minimal damage to the tissues.

Since the normal cornea has a relative hypotonicity between the tears, on the outer surface, and the aqueous, on the inner surface, the normal epithelium represents a state of relative dehydration except for slight epithelial edema, as seen at the normal limbus. The hydrating effect (edema of corneal epithelium) of swimming in fresh water, or the dehydrating effect of glycerin, of the contact lens with hypertonic solution or of the ingenious air-tight calcium chloride spectacles, as used by Cogan, is a further example of the property of dehydration by evaporation.

Read before the Section on Ophthalmology at the Ninety-Ninth Annual Session of the American Medical Association, San Francisco, June 29, 1950.

From the Western Reserve University School of Medicine and the University Hospitals of Cleveland, Department of Surgery, Ophthalmological Service (Dr. Johnson).

1. Cogan, D. G.: Some Practical Considerations Pertaining to Corneal Edema, Arch. Ophth. **25**:552-556 (April) 1941. Cogan, D. G., and Kinsey, V. E.: Cornea: Transfer of Water and Sodium Chloride by Osmosis and Diffusion Through Excised Cornea, ibid. **27**:466-476 (March) 1942. Cogan, D. G.; Hirsch, E. O., and Kinsey, V. E.: Cornea: Permeability Characteristics of Excised Cornea, ibid. **31**:408-412 (May) 1944. Holt, M., and Cogan, D. G.: Cornea: Permeability of Excised Cornea to Ions, as Determined by Measurements of Impedance, ibid. **35**:292-298 (March) 1946.

With age certain persons exhibit not only greatly increased numbers of Hassal-Henle bodies, but also an increase in their size, or after uveitis the endothelium may become amorphous, or amorphous with a great increase in the number and size of the Hassal-Henle bodies. Other evidence of diseased or damaged endothelium may be precipitated protein membrane, a ruptured Descemet membrane or the herniation of vitreous or lens capsule against the endothelium in the aphakic eye. Each condition discussed produces physiological impairment of the normal osmotic circulation of fluid from the limbus through the epithelium or endothelium, as outlined in the original schematic drawing of Cogan.

Figure 4 illustrates that epithelial vesicles may arise when there is an inherently low difference in osmotic pressure between the tears and the cornea or when endo-

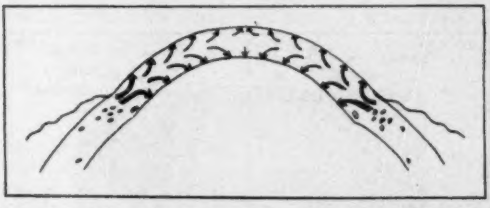


Fig. 1 (after Cogan [1]).—Schematic drawing illustrating the theory of fluid movement through the cornea. Arrows indicate the direction of flow, and the density of the arrows from the periphery to the center indicates the relative amount of fluid movement. The amount of movement toward the anterior and that toward the posterior surface, while shown by the density of the arrows to be equal, are not known.

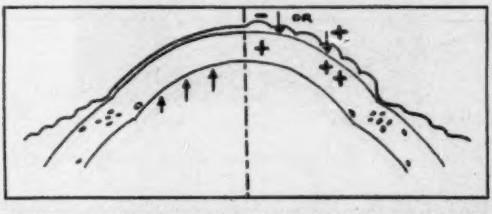


Fig. 2.—(Left) Bullous keratitis cannot be produced by forcing fluid into the cornea from the aqueous. (Right) Bullous keratitis results only from the absorption of fluid from the outside through hypertonicity of the cornea.

thelial damage could cause an increase in osmotic tension of the corneal fluid. In either situation, it may be seen that the addition of hypertonic solution to the tears would immediately cause dehydration of the epithelial vesicles. The prolonged action of such solutions would, however, remove fluid not only from the bullae but also from the stroma, so that the secondary effect would be that of relative hypertonicity of the cornea with reformation of the blebs after the withdrawal of the hypertonic solution.

Furthermore, especially with relation to such chronic conditions as advanced cornea guttata, macrorecurrent erosion, amorphous endothelium or precipitated protein membrane following uveitis or herniation of vitreous against the endothelium, the ruptured bullae constitute a definite irritant, which causes epiphora

and further dilution of the tears, the consequent lowering of the osmotic concentration resulting in more and larger bullae. These factors are severest at night, when the closed lids prevent evaporation and its effect on osmotic concentration of the precorneal film.

Long evident has been the problem not only of clearing the bullae during the day but, especially, of preventing the reformation of bullae during sleep. The personal experiences of one of us (L. V. J.) in attempting to decrease function of the lacrimal gland by extirpation or by diathermy has left much to be desired, failures having been considered incomplete destruction or hypertrophy of remaining or accessory lacrimal gland tissue.

A procedure satisfactory in preventing the formation of the serous component of tears has been resection of the greater superficial petrosal nerve. Further,

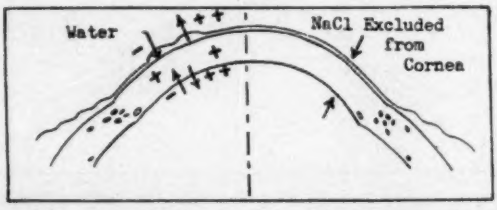


Fig. 3.—The epithelium and endothelium are impermeable to sodium chloride and thus act as a semipermeable membrane. The stroma is permeable to sodium chloride and is unable to act as a semipermeable membrane. Water thus remains, to produce bullous keratitis, because there is no further osmotic pressure to transfer the water through the stroma.

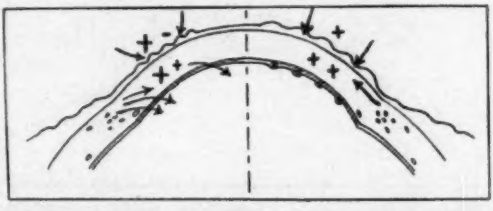


Fig. 4.—(Left) Traumatic relapsing keratitis, with recurrent erosion. Persons with traumatic relapsing keratitis may have an inherently low osmotic difference in pressure between the tears and cornea, so that any dilution of the tears, as from epiphora, would result in vesicles. (Right) Senile guttate keratitis. Endothelial damage could cause an increase in osmotic tension of the corneal fluid.

although the eye becomes dry, we have observed no suggestion of keratitis sicca. We have observed that after this procedure the serous component of the tears was eliminated, with the immediate withdrawal of fluid from the epithelial bullae because of the increased electrolytic content of the precorneal mucous film. Likewise, after operation diurnal variations in vesicle formation do not occur, the hypertonic electrolytic concentration probably remaining fairly constant night and day.

The greater superficial petrosal nerve originates in the geniculate ganglion of the facial nerve within the petrous portion of the temporal bone. The nerve emerges from the hiatus canalis facialis to run in a groove anteromedially and pass

behind the semilunar (gasserian) ganglion or the mandibular nerve and along the side of the internal carotid artery to the vidian canal (fig. 5). A sympathetic nerve branching from the carotid plexus, the deep petrosal nerve, joins the greater superficial petrosal at this point to form the vidian nerve (nervous canalis pterygoidei), which terminates in the sphenopalatine ganglion.

Vasodilator and secretory fibers pass through this nerve to supply the mucous membrane of the nose, the upper portion of the pharynx, the soft palate, the roof of the mouth and the upper lip (Chorobski and Penfield[2]); secretory fibers supply the ipsilateral lacrimal gland as well. The secretory fibers in the greater superficial petrosal nerve synapse in the sphenopalatine ganglion with fibers to the lacrimal gland; hence they must be considered preganglionic (Mettler[3]).

It is generally believed that stimulation of this nerve will result in (1) dilatation of the pial arteries, (2) lacrimation and (3) transmission of pain response from the pial vessels, and that these parasympathetic reactions are opposed by the

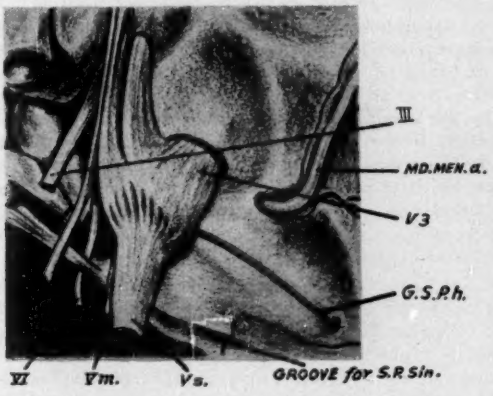


Fig. 5.—Relations of the greater superficial petrosal nerve.

sympathetic responses, as elsewhere in the body. It was apparent that intracranial section of the greater superficial petrosal nerve would effect a preganglionic interruption of the parasympathetic (secretory) fibers to the lacrimal gland, in which our primary interest lay.

The surgical approach is much like the temporal approach to the sensory root of the fifth nerve. With the patient under light thiopental (pentothal®) anesthesia supplemented with local infiltration anesthesia, a short vertical incision is made in the temporal area perpendicular to the zygomatic arch. The incision is carried through the temporal muscle to the temporal bone. An opening the size of a 50 cent piece is made, exposing the temporal portion of the dura mater. An extradural approach is made to the hiatus canalis facialis, which lies posterolateral to the

2. Chorobski, J., and Penfield, W.: Cerebral Vasodilator Nerves and Their Pathway from the Medulla Oblongata, with Observations on Pial and Intracerebral Vascular Plexus, Arch. Neurol. & Psychiat. **28**:1257-1289 (Dec.) 1932.

3. Mettler, F. A.: Neuroanatomy, ed. 2, St. Louis, C. V. Mosby Company, 1948, p. 82.

gasserian ganglion. In some instances it may be desirable or necessary to clip and divide the middle meningeal artery at the foramen spinosum. When the hiatus is found, the groove is readily noted. It is desirable to section the nerve within the groove before attempting to manipulate it further, lest facial paralysis result from the trauma when traction is applied to the area of the geniculate ganglion. When the nerve has been divided, the central end is picked up, usually reflected back on itself and a silver clip or two applied. The nerve end frequently is cauterized to prevent regeneration. The proximal end of the nerve is then picked up, a clip is applied as far distally as possible, and the intervening portion of the nerve is removed. A routine closure is then made. The patient is usually ambulatory in a day or two and ready for discharge on the fourth or fifth day. Almost immediately after operation there is a noticeable diminution the the amount of lacrimation, as well as some decrease in pain. The Schirmer test confirms the decrease in lacrimation.

Typical of our experience with this procedure are the cases summarized.

Mr. DeC. had amblyopia ex anopsia in the right eye, the strabismus having been corrected late in adolescence. Senile guttate keratitis had progressed in both eyes, with reduction of visual acuity in the left eye to 20/200. Another surgeon had performed an optical iridectomy, hoping to improve the patient's acuity sufficiently that he be employable. The operation was immediately followed by bleb formation, and one year later he consulted me, seeking relief from the pain. Reflex epiphora from ruptured blebs added to the vicious cycle. The corneal edema almost obscured the iridectomy scar and the iris markings. Four weeks after operation the iris markings were visible, and there remained but faint scarring from ruptured corneal bullae, of one year's duration. Dehydrated mucus was to be seen at the inner canthus. Visual acuity of 20/30 was present at the end of eight weeks and has been maintained. Relief from pain occurred prior to the patient's discharge from the hospital.

Mrs. R. had had a prolonged postoperative course following cataract extraction. She understood that an iritis had developed. About 18 months after operation severe bullous keratitis was noted, and when the condition was cleared with glycerin either cyclitic membrane or vitreous in contact with the endothelium was observed. Excessive lacrimation, as a result of reflex stimulation from the ruptured blebs, was present. Prior to operation the iris markings were obscured, whereas four weeks after the neurectomy the cornea permitted 20/30 vision, and the eye was almost free from irritative injection of the conjunctiva.

COMMENT

It is to be emphasized that the sequence of edema of the corneal epithelium and bleb formation with rupture of the bullae constitutes (by abrasion of the cornea) a powerful stimulant for severe epiphora and further dilution of the salt content of the precorneal film. Thus, a vicious circle of osmotic hypotonicity is established. When, after the circle of continuing hypotonicity was broken and the patient was relieved of the ruptured blebs and epithelial edema, slight regeneration did occur, tears might be present with an intact epithelium. Clinical observation in cases of this condition does not give evidence of a return of the corneal disease. The total absence of tears is not necessarily a criterion of absence of bleb formation, and in certain mild cases total absence of tears may not even be desirable. It is the prevention of dilution of the precorneal film by excess tears that should be the minimal criterion of success. It might be emphasized that so long as the bullae do not recur the question whether or not there has been (or

should be) some regeneration in a small percentage of the cases is of academic interest to neurosurgeons only. When resection of the greater superficial petrosal nerve was done for the relief of unilateral headache, the production of a dry eye was incidental; other authors noted some return of function in the lacrimal glands of variable degree in 31 operations on 26 patients.[4] While it is stated that section of the greater superficial petrosal nerve may be followed by regeneration, the procedure referred to in this discussion is neurectomy (resection of a portion of the nerve) with a silver clip placed over the reflected cut ends. In some instances the cautery is applied to the severed nerve ends to further prevent regeneration.

Present observations have shown that such a condition as precipitated protein membrane or vitreous in contact with the endothelium can produce edema of the cornea, and that, in certain cases at least, prevention of dilution of the salt content of the precorneal film by normal or excessive (reflex) lacrimal secretion may allow freedom from bullous keratitis. It is suggested that reflex stimulation of the greater superficial petrosal nerve from branches of the fifth cranial nerve other than the ophthalmic branch (excluding the condition of traumatic relapsing keratitis with bleb formation) or stimulation of the portio minor of the seventh nerve (nervus intermedius) could be a factor in producing microscopically or grossly recurrent erosion. This problem is under investigation.

10515 Carnegie Avenue.

ABSTRACT OF DISCUSSION

DR. S. RODMAN IRVINE, Cleveland: The rationale of resection of the greater superficial petrosal nerve is based on the interruption of the efferent arc of the tearing reflex, which results in permanent hypertonicity of the precorneal film by greatly lessening the serous element of the tears. Retrobulbar injection of alcohol produces, to a less degree, the same effect but does so by obliterating the sensory pain stimulus that is responsible for increased tearing. It is also possible that alcohol inhibits the postganglionic parasympathetic fibers in the orbit, thus producing the identical physiological effect described by the author. Clinically, during the past three years, my colleagues and I have achieved satisfactory results in many instances of bullous keratitis by retrobulbar injections of alcohol. We have found that relief from symptoms lasts longer than the obvious impairment of nerve function produced by such injection. Dr. A. E. Maumenee has described a technic which is easy to perform and which affords relief from pain without producing a disturbing paresis of extraocular muscles in the majority of cases.

I was greatly interested to hear that Dr. Johnson did not find that keratitis sicca resulted from removal of the serous component of the tears. I should like to know how many patients he has observed after the operation described and how long they have been followed since operation. In the light of present concepts, it is indeed remarkable that keratitis sicca does not develop in some instances.

It would be a great service if Dr. Johnson were to present his paper to the neurologists, as well as the ophthalmologists; after all, if this procedure is to be adopted the neurosurgeons must be convinced of its simplicity and efficacy. The effect of this operation might be temporarily simulated by injecting local anesthetic into the region of the lacrimal nerve and gland. I wonder whether Dr. Johnson has tried this.

4. Gardner, W. J.; Stowell, A., and Dutlinger, R.: Resection of the Greater Petrosal Nerve in the Treatment of Unilateral Headache, J. Neurosurg. 4:105-114 (March) 1947.

DR. HAROLD G. SCHEIE, Philadelphia: The authors have presented an ingenious approach to one of the most discouraging problems in ophthalmology. Corneal edema is probably most commonly associated with endothelial dsytrophy. It also occurs all too frequently after operations on the anterior segment of the eye, as a result of adhesion incarcerations of the iris, vitreous or capsular material which prevent sealing of the inner aspect of the wound.

Cogan has best explained the origin of this corneal edema. He assumes the corneal stroma to be covered on each side by a semipermeable membrane, the epithelium externally and the endothelium internally. These membranes are permeable to water but are inpermeable to salts. The stroma normally is kept in a state of dehydration because the aqueous and precorneal mucus film are both hypertonic to the stroma and, as a result, continually draw water from the stroma.

A defect in the corneal endothelium, therefore, allows the aqueous and its crystalloids to enter the stroma. Fluid is therefore retained in the stroma, causing corneal edema with bleb formation. Hypertonic solutions applied to the epithelial surface of the eye tend to diminish this edema by drawing water from the stroma, but such a method is not practical clinically.

The authors have attempted to accomplish a similar purpose on a permanent basis by rendering the precorneal film hypertonic through reduction of lacrimal secretion as a result of destruction of the secretory nerve fibers to the lacrimal gland. The results reported by them are dramatic.

I have had no experience with the method, but during the past three years I have attempted, in a small number of patients, to free adhesions from the inner aspect of the wound by cyclodialysis with subsequent injection of air. The number of patients cured was so small, however, as to throw doubt on the value of the procedure.

The method suggested by Dr. Johnson and Dr. Nosik is promising and worthy of trial. The procedure, in their hands, seems safe, although one would fear the danger of facial paralysis.

Aside from the practical application, the authors seem to have made a definite contribution to knowledge of the physiology of the lacrimal gland. There is still some debate on the effect of the sympathetic and the parasympathetic fibers on lacrimal secretion. I should like to inquire as to any data concerning changes in the amount or composition of the lacrimal secretion following section of the petrosal nerve.

DR. LORAND V. JOHNSON, Cleveland: In answer to Dr. Irvine's questions: We have performed this operation on seven patients and have observed them for a year and a half. Concerning the injection of alcohol into the orbit, I might say that the fibers there are postganglionic and the fibers we cut are preganglionic, or upper motor neurons. I am of the opinion that the lower, or postganglionic, fibers injected with the alcohol would regenerate. There is even a question whether the preganglionic fibers regenerate. As I said, most of these neurectomies in the past have been done for the relief of headache, and the production of the dry eye was incidental, and not desired. I am not certain that there is not some regeneration there.

Dr. Scheie's question of the study of the function of the sympathetic and parasympathetic fibers innervating the lacrimal gland is one that interested us early. We have at present under way certain studies comparing the patients who had sympathectomies with the patients who had section of the parasympathetic fibers and have no serous component in their tears. As Dr. Irvine mentioned, I, too, regret that the program for the Section on Nervous and Mental Disease was completed and, consequently, that Dr. Nosik was unable to present simultaneously his portion of this paper to them.

In Cleveland, and in other cities where resection of the petrosal nerve has been done for relief of histamine cephalalgia, the extradural operation is viewed as a minor neurosurgical procedure. Neurosurgeons who have considered the nerve only as a structure to be avoided during surgical procedures for trigeminal neuralgia, and who fear the complication of a dry eye—in that case, superimposed on neuroparalytic keratitis—are cautious to be certain that a permanently dry eye is desirable.

I might say further that ophthalmologists wishing to be certain that the neurosurgical consultant has actually identified and cut the greater superficial petrosal nerve, and not a fold of dura by mistake, may request that a pathological identification of the resected portion be supplied him as proof that the nerve has actually been cut.

The relief of headache was striking in two of the patients who had postcataract uveitis with bullous keratitis without increased pressure, the section of the nerve immediately resulting in relief from the severe one-sided headache. It is possible that many patients with uveitis who have the unilateral pain may have a superficial petrosal discharge and that the operation for the relief of this headache is of the same type as that which neurosurgeons are at present doing for relief of the headache.

CEREBELLAR-MACULAR ABIOTROPHY

WILLIAM H. HAVENER, M.D.
ANN ARBOR, MICH.

RECENTLY at Cleveland City Hospital and at Lakeside Hospital there were observed a father and a daughter, both of whom had degenerative disease of the nervous system. The father showed both cerebellar and macular degeneration, and because of this unusual combination the cases are presented.

PRESENTATION OF CASES

The patient, a Negro aged 28 (Cleveland City Hospital no. 295-788), had been well until five years before admission, at which time he noted gradually failing vision. For two or three years he had noted slowly progressive ataxia, clumsiness and nervousness (tremors) and complained that people thought he was drunk because of his gait. There was a loss of weight of 36 pounds (16.3 Kg.) in the past five years. His occupation was that of molder in a foundry.

His only other illness had been gonorrhea in 1948, which had been treated with penicillin.

His mother died of unknown cause when he was 2 years old. His father, aged 49, who was living and healthy, was a rice farmer in Arkansas. A maternal half-sister had died of unknown cause at the age of 11 years. A maternal half-brother, aged 33, was well. Three siblings were healthy. The patient had had five children, the 3 year old daughter whose death of cerebellar degeneration is described in this article, a son who died at the age of 23 months, after one hour of screaming (?), and three well children, aged 5, 2 and 1 years, who had been examined and showed no neurological or ophthalmologic degenerations. His wife, aged 24, was well.

Physical examination revealed a well developed but poorly nourished Negro who was essentially normal except for the neurological signs. Except for the optic nerve, the cranial nerves were normal. Both disks showed slight temporal pallor. Visual acuity was 6/60—that of complete loss of macular vision. Both maculas showed degenerative changes occupying an area of about ½ disk diameter, in which area there were finely scattered pigment and a somewhat iridescent sheen. The retinal arterioles were somewhat narrower than usual. No pigmentary degeneration of the retina was noted. The visual fields showed a bilateral central scotoma for 1 mm. white and 10 mm. red, which included the blindspot.

Mental function was somewhat subnormal. Stereognosis and position and vibration senses were excellent. There were no paresthesias or sensory changes. A cerebellar tremor of the head became apparent when he tried to carry out commands but was absent at rest. There were slight intention tremor and asynergy of both arms, especially the left, and slight adiadokokinesis on the left. There was bilateral unsteadiness in the heel-shin test. The patient had very poor balance with his eyes open or closed and walked unsteadily on a base a little wider than usual. The reflexes were equal and hyperactive with some pendulation of the left leg. There was no nystagmus. Speech was somewhat indistinct. Lumbar puncture revealed the fluid to be under normal pressure, with a protein content of 50 mg. per 100 cc. and 3 monocytes per cubic millimeter; the complete blood count, blood urea nitrogen, serological reactions, fasting blood sugar, urine and posteroanterior roentgenogram of the chest were normal. A pneumoencephalogram, with removal of 210 cc. of fluid, showed an enlarged basal cistern, consistent with the diagnosis of advanced atrophy of the cerebellum (figure).

A 3 year old Negro girl (Lakeside Hospital no. 284-433) was well until the age of 18 months, at which time she lost energy and interest in playing. At the age of 2 years she was no

longer able to walk well and "shook all over when she tried to move." She was completely unable to walk after the age of 2½ years. Vision was not noted to be defective; but she was so severely deteriorated mentally that visual acuity could not be determined.

Physical examination in January 1950 revealed a lethargic, chronically and seriously ill, well developed but emaciated child. There were generalized muscular wasting and absence of the triceps and radial reflexes bilaterally. She had pronounced incoordination. No other pathologic condition was noted; the fundi were normal; there was no lymphadenopathy or splenomegaly.

Laboratory Tests.—A complete blood count, urinalysis and determination of the carbon dioxide tension, p_H, potassium, sodium, calcium, phosphorus and phosphatase of the blood all gave normal results. There was no porphyrin in the urine. Lumbar puncture showed a fluid under normal pressure, with 46 mg. of protein per 100 cc. and 2 monocytes per cubic millimeter.

Pneumoencephalogram showing excess air in the posterior fossa, indicating cerebellar atrophy.

A pneumoencephalogram showed slight dilatation of the lateral and third ventricles. Roentgenograms of the skull and chest showed a normal condition, the only anomaly being an azygos lobe. An ophthalmologic consultation revealed nothing pathological—specifically, no optic nerve atrophy or macular degeneration. The patient died on Jan. 30, 1950 of bilateral bronchopneumonia, with a clinical diagnosis of degenerative disease of the central nervous system.

Autopsy showed bilateral bronchopneumonia and severe wasting of the musculature. The organs were otherwise normal, except for the cerebellum, which was greatly reduced in size. The cerebellum with the pons and medulla weighed only 54 Gm.; the total weight of the brain was 799 Gm. (normal, 1,141 Gm.). There was no abnormality of the cerebral cortex, basal ganglia, thalamus or medulla. Although the cerebellum was extremely small, with olivopontocerebellar atrophy, it was microscopically normal. The Purkinje cells, granular cells, plexiform layer, white matter and cerebellar vessels were normal except for a decreased number, due to the small size of the organ. Unfortunately, pathological examination of the eyes was not made.

COMMENT

In this case a hereditary cerebellar defect was evidenced in both father and daughter by extreme smallness of the cerebellum, as disclosed pneumoencephalographically and at autopsy, respectively. Neither patient showed an extremely full blown cerebellar syndrome, the father presenting unsteadiness on walking with slight asynergy, and the daughter's condition permitting only the diagnosis of degenerative disease of the central nervous system, without special reference to the cerebellum. That such a condition is not inconsistent with virtual absence of the cerebellum is seen by Brown's [1] description of a case in which operation was performed for astrocytoma, with removal of both anterior and posterior cerebellar lobes bilaterally, leaving little more than the vermis; no clinically detectable cerebellar signs were present six months after operation, presumably owing to compensation by other parts of the brain. Many of Schut's [2] 45 patients with hereditary cerebellar atrophy showed minimal cerebellar signs.

This condition was not an aplasia, but, rather, a degeneration (abiotrophy) in both cases, as witness the daughter's normal development and ability to walk until the age of 18 months and the normal health of the father until the age of 25, when progressive symptoms appeared. In the father there was also primary degeneration of the macula; in the daughter, mental deterioration to the point of vegetation. We believe that these abiotrophies must be considered related, rather than a coincidence in the same patient. Probably the best example of such a coincidence is amaurotic familial idiocy, in which similar lipid degeneration is observed in all regions of the nervous system, but especially in the macular and cerebellar nerve cells (Greenfield and Holmes [3]). However, the present cases do not fit into the classification of amaurotic familial idiocy, for there was no lipid degeneration in the daughter's brain and the father was too old for his disease to be considered the juvenile form. The father's case fits well into the classification of Marie's cerebellar hereditary ataxia (hereditary sclerosis, cerebellar form), in which the patient exhibits progressive unsteadiness when walking, beginning after the twentieth year, often accompanied with optic nerve atrophy and mental deterioration and characteristically showing hyperactive reflexes. The pathologic feature in Marie's ataxia is marked cerebellar atrophy—the cerebellum may be as small as 43 Gm. (normal 145 Gm.).

One of the most interesting features of these cases is the great difference in age of onset—3 and 23 years—which indicates that the cerebellar abiotrophies are more closely related than the many classifications suggest and supports Bing's [4] belief that Marie's cerebellar ataxia of adults is closely related to Friedreich's spinocerebellar ataxia (hereditary sclerosis, spinal form) of children, if indeed they are not forms of the same disease. Although hereditary cerebellar degeneration within one family tends to appear at the same age, the phenomenon of anticipation

1. Brown, J. R.: Localizing Cerebellar Syndromes, J. A. M. A. **141**:518-521 (Oct. 22) 1949.

2. Schut, J. W.: Hereditary Ataxia: Clinical Study Through 6 Generations, Arch. Neurol. & Psychiat. **63**:535-568 (April) 1950.

3. Greenfield, J. G., and Holmes, G.: Histology of Juvenile Amaurotic Idiocy, Brain **48**:183-217 (June) 1925.

4. Bing, R.: Textbook of Nervous Diseases, translated and enlarged by W. Haymaker, ed. 5, St. Louis, C. V. Mosby Company, 1939.

is very common, and the disease may appear two to 20 years earlier in the children than in the parents. Prognosis is best based on the history of the family strain of the degenerative disease; in general, the younger the age of onset, the rapider the progress. This is true in both cerebellar (Schut) and macular (Falls [5]) abiotrophy.

The present case is unique in that the combination of cerebellomacular degeneration is rather uncommon. There are many reports of the cerebromacular degeneration of amaurotic familial idiocy, and of the frequent coincidence of optic nerve atrophy and hereditary ataxias, but not of macular degeneration with cerebellar atrophy. One wonders whether macular degeneration may have been overlooked in some of the cases of optic nerve atrophy and cerebellar degeneration.

SUMMARY

1. A rather unusual combination of hereditary degeneration of the cerebellum and of the macula is described.

2. The two members of the family reported on exhibit the phenomenon of anticipation of heredity, illustrate the poorer prognosis of early onset and emphasize the artificiality of the age limit in differentiating Friedreich's and Marie's forms of hereditary sclerosis.

5. Falls, H. F.: Hereditary Congenital Macular Degeneration, Am. J. Human Genet. **1**:96-104 (Sept.) 1949.

CLINICAL TRIAL WITH CHLORAMPHENICOL IN OCULAR INFECTIONS

IRVING H. LEOPOLD, M.D.
PHILADELPHIA

IT IS well known that four criteria are of major importance in evaluating antibiotics in ophthalmology; namely, (1) ease of penetration into ocular tissues when the drug is locally or systemically administered; (2) toxicity for ocular tissues; (3) effectiveness against standard experimental ocular infections; (4) effectiveness against clinical ocular infections.

The ease of administration, cost, availability, general tissue toxicity and range of antibiotic activity are also of importance, but these are not solely ophthalmologic problems. Data concerning the four main criteria have been reported for penicillin,[1] streptomycin,[2] bacitracin [3] and aureomycin.[4] Recently, an evalu-

---

From the Research and Clinical Department of Wills Hospital.

Presented before the Section of Ophthalmology of the Clinical Congress of the American College of Surgeons, Boston, Oct. 25, 1950.

1. (*a*) Leopold, I. H.: Pharmacology and Toxicology: A Review of the Literature, Arch. Ophth. **44**:300 (Aug.) 1950. (*b*) Leopold, I. H.; Nichols, A. C., and Vogel, A. W.: Penetration of Chloramphenicol U. S. P. (Chloromycetin®) into the Eye, ibid. **44**:22 (July) 1950. (*c*) Leopold, I. H.: Intravitreal Penetration of Penicillin, and Penicillin Therapy of Infections of Vitreous, ibid. **33**:211 (March) 1945. (*d*) Leopold, I. H., and LaMotte, W. O., Jr.: Penetration of Penicillin in Rabbit Eyes with Normal, Inflamed and Abraded Corneas, ibid. **33**:43 (Jan.) 1945. (*e*) Sorsby, A.: Modern Trends in Ophthalmology, vol. 2, New York, Paul B. Hoeber, Inc., 1948. (*f*) Sorsby, A., and Burn, R. A.: Treatment of Infected Corneal Ulcer by Subconjunctival Injection of Penicillin in Doses of 1,000,000 Units, Brit. J. Ophth. **34**:16, 1950. (*g*) Struble, G. C., and Bellows, J. G.: Studies on the Distribution of Penicillin in the Eye and Its Clinical Application, J. A. M. A. **125**:685 (July 8) 1944. (*i*) von Sallmann, L.: Controversial Points in Ocular Penicillin Therapy, Tr. Am. Ophth. Soc. **45**:570, 1947. (*j*) von Sallmann, L., and Meyer, K.: Penetration of Penicillin into the Eye, Arch Ophth. **31**:1 (Jan.) 1944; Penetration of Penicillin into the Eye: Further Studies, ibid. **34**:195 (Sept.) 1945.

2. (*a*) Bellows, J. G., and Farmer, C. J.: Streptomycin in Ophthalmology, Am. J. Ophth. **30**:1215, 1947. (*b*) Bietti, G. B.: Use of Paraaminosalicylic Acid Alone and in Association with Streptomycin in Ocular Tuberculosis: Experimental and Clinical Investigations, Arch. Ophth. **43**:431 (March) 1950. (*c*) Leopold, I. H., and Nichols, A.: Intraocular Penetration of Streptomycin Following Systemic and Local Administration, ibid. **35**:33 (Jan.) 1946. (*d*) Lepri, G., and Fornaro, L.: Combination of Streptomycin and Paraaminosalicylic Acid in Experimental Ocular Tuberculosis, Arch. ottal. **53**:129, 1949. (*e*) MacAskill, J., and Weatherall, M.: Streptomycin and Promanide in Experimental Ocular Tuberculosis, Brit. J. Ophth. **34**:147, 1950. (*f*) Rees, R. J. W., and Robson, J. M.: Experimental Tuberculous Infections of the Cornea of the Mouse, Brit. J. Pharmacol. **5**:77, 1950. (*h*) Tucker, W. B.; Fellos, H. H.; Gale, J. W.; Jenkins, D. E.; Kirby, M. M. W.; Lincoln, E. M.; Schwartz, J. H., and Trumble, H. G.: Current Status of Drug Therapy in Tuberculosis, Am. Rev. Tuberc. **61**:430, 1950. (*i*) Woods, A. C.: Therapeutic Action of Streptomycin and Promizole® in Clinical Ocular Tuberculosis: A Preliminary Report, Arch. Ophth. **42**:521 (Nov.) 1949.

ation of the ocular penetration and toxicity of chloramphenicol has been reported.[1b] It was found that chloramphenicol is stable in solution and penetrates readily into the ocular tissues and fluids after systemic (oral and intravenous) and local administration. These studies with chloramphenicol have been continued with the intent of evaluating its clinical effectiveness.[5]

The results of clinical experience with chloramphenicol (chloromycetin®) in treatment of ocular infections are presented.

CONJUNCTIVITIS

The results of chloramphenicol therapy in 103 eyes with conjunctivitis are presented in table 1. In all cases smears and cultures of the conjunctival secretions

TABLE 1.—*Local Administration of Chloramphenicol Solution (2.5 Mg./Cc.) in Treatment of Conjunctivitis* *

No. of Eyes	Diagnosis	Culture	Cytologic Findings in Exudate or Scrapings	Improved	Unimproved
8	Bacterial conjunctivitis	Esch. coli	Polymorphonuclears	8	0
6		H. influenzae	Polymorphonuclears	6	0
3		Strep. viridans	Polymorphonuclears	1	2
16		Staph. aureus	Polymorphonuclears	11	5
8		Strep. hemolyticus	Polymorphonuclears	6	2
3		Pneumococcus	Polymorphonuclears	2	1
10		Morax-Axenfeld bacillus	Polymorphonuclears	8	2
2		Meningococcus	Polymorphonuclears	2	0
1		Gonococcus	Polymorphonuclears	1	0
	Other forms of conjunctivitis				
4	Epidemic	Sterile	Monocytes	4	0
12	Allergic	Sterile	Eosinophils	2	10
2	Follicular	Sterile	Monocytes	2	0
4	Phlyctenular	Staph. aureus Strep. hemolyticus	Polymorphonuclear leukocytes; rare eosinophil	4	0
2	Phlyctenular	Sterile	Lymphocytes	0	2
20	Chronic catarrhal	Sterile	None to few monocytes and lymphocytes	12	8
2	Inclusion blenorrhea	Sterile	Inclusion bodies	2	0
103			Totals	71	32

* Therapy schedule: 1 drop in the involved eye every 10 minutes for six doses; then every 30 minutes for four doses; then every hour for five doses; thereafter every two hours while the patient was awake. Therapy was continued for 48 hours after the conjunctiva was clinically normal.

and scrapings were made. Seventy-one eyes showed improvement after local therapy with chloramphenicol solution in a concentration of 2.5 mg. per cubic centimeter. The therapy scheduled consisted of instillation of drops of the solution

3. Bellows, J. G., and Farmer, C. J.: Use of Bacitracin in Ocular Infections, Am. J. Ophth. **31**:1070, 1948. Locke, J. C.: Experimental Studies with Antibiotics, Bacitracin, Streptomycin, Penicillin and Antibiotic Mixtures in Intraocular Infections with Penicillin Resistant Staphylococci, ibid. **32** (June, pt. 2):135, 1949.

4. (*a*) Bellows, J. G.; Richardson, V. M., and Farmer, C. J.: Aureomycin in Ophthalmology, Am. J. Ophth. **33**:273, 1950. (*b*) Braley, A. E., and Sanders, M.: Aureomycin in Ocular Infections: Preliminary Report, J. A. M. A. **138**:426 (Oct. 9) 1948. (*c*) Burstein, F.: Sensitivity to Aureomycin, Am. J. Ophth. **33**:973, 1950. (*d*) deRoetth, A., Jr.: Penetration of Aureomycin into the Eye, Arch. Ophth. **42**:365 (Oct.) 1949. (*e*) Duke-Elder, A.; Ainsle, D., and Boase, A. J.: Aureomycin in Ophthalmology, Brit. J. Ophth. **34**:30, 1950. (*f*) Thygeson, T., and Hogan, J.: Aureomycin in Herpes Simplex, Am. J. Ophth. **33**:958, 1950.

5. The drug was supplied by Parke, Davis & Company, Detroit.

every 10 minutes for six doses, then every 30 minutes for four doses and then every hour for five doses. Thereafter, the drops were used every two hours while the patient was awake and there was still evidence of an active conjunctival disease. When the conjunctiva cleared, administration was reduced to four times daily for the next 48 hours.

In the majority of these eyes, use of chloramphenicol was the initial therapy, and it must be kept in mind that other therapies might have been equally successful. In several instances, however, other therapies were tried before chloramphenicol was used. In four eyes in which Escherichia coli was found to be the infecting agent, both penicillin and aureomycin had been used locally, with unsuccessful results, whereas chloramphenicol cleared the condition within 48 hours.

In two eyes in which Hemophilus influenzae was apparently the etiological agent, penicillin, sodium sulfacetimide and aureomycin had been used without

TABLE 2.—*Chloramphenicol in Treatment of Keratitis*

No. of Eyes	Diagnosis	Cultures of Cul-de-Sac	Improvement	No Improvement
8	Dendritic keratitis	Sterile	8	0
3	Disciform keratitis	Sterile	2	1
2	Hypopyon keratitis	Sterile	2	0
2	Hypopyon keratitis	Ps. aeruginosa	1	1
1	Corneal abscess	Ps. aeruginosa; Pneumococcus	1	0
1	Corneal abscess	Esch. coli; Staph. aureus	1	0
1	Corneal abscess	Strep. hemolyticus; mir Nedden bacillus; Pneumococcus	0	1
6	Marginal ulcers	Sterile	2	4
2	Acne rosacea keratitis	Staph. aureus	2	0
6	Superficial punctate keratitis	Sterile	2	4
1	Exposure keratitis (exophthalmos)	Sterile	1	0
33		Total	22	11

success, prior to favorable results with chloramphenicol. In the case of gonococcic conjunctivitis, both penicillin and chloramphenicol were used. In the initial stages penicillin had been used in inadequate dosage. It was believed, therefore, that the organism might have formed a resistance to the penicillin, and therefore chloramphenicol was used as an additional therapeutic agent. It was the only case of conjunctivitis in which chloramphenicol was used systemically.

KERATITIS

In the therapy of keratitis, chloramphenicol was used systemically, as well as locally. Experimental studies now under way at the Wills Hospital indicate that local therapy alone will control standard viral infections of the cornea. However, to be certain that the maximal effect of the drug on the corneal lesion would be obtained, local and systemic therapy were combined in these clinical studies. Systemic administration in all cases consisted of an initial dose of 3 Gm., or 12 kapseals,* followed by 0.5 Gm. (2 kapseals*) every four hours. The local therapy employed was instillation of 2 drops of chloramphenicol solution, 2.5 mg. per cubic centimeter, at hourly intervals (table 2).

In none of the cases of dendritic keratitis was staining shown after an interval of six to seven days. Definite improvement, as shown by reduction in staining area, could be noted within 48 hours after the institution of therapy in each eye so treated.

The eyes with hypopyon keratitis required two to three weeks before they were completely quiet, but definite signs of improvement appeared within 72 hours.

A patient with marginal ulcers showed dramatic response to systemic administration of chloramphenicol. Within 24 hours the ulcerations had shown definite improvement. However, this patient had a recurrence 10 days later. He was found to have many allergies, including a marked sensitivity to the Staphylococcus toxin.

The two eyes with superficial punctate keratitis that showed dramatic improvement following the use of chloramphenicol were in the same patient, whereas two other patients showed no response.

Two eyes with corneal abscess following removal of embedded corneal foreign bodies responded to therapy. In both cases enucleation had been advised after massive systemic treatment with penicillin and streptomycin, together with fever therapy, Saemisch section, and local therapy with penicillin, streptomycin and aureomycin, had failed. One eye showed Pseudomonas aeruginosa (Bacillus pyocyaneus) and Pneumococcus, both of which were sensitive to chloramphenicol, and the other showed a sensitive Bacterium coli and a relatively insensitive Staphylococcus aureus. A third eye with a corneal infection following a foreign body injury failed to respond to treatment with any antibiotic, including chloramphenicol. The other drugs tried were aureomycin, penicillin, streptomycin and terramycin, administered systemically and locally. The organisms were hemolytic Streptococcus, zur Nedden's bacillus and Pneumococcus. These organisms were sensitive to chloramphenicol, but more so to terramycin.

UVEITIS

Chloramphenicol was tried in 10 cases of uveitis. Systemic treatment with chloramphenicol was used in the same fashion as described in the preceding section. In six cases other therapeutic methods had been employed, without success, before chloramphenicol was tried. Although these cases had been thoroughly studied, the diagnosis was still uncertain. Roentgenologic studies of the chest; Mantoux and other skin tests, such as those with brucellergin, Frei antigen and Staphylococcus toxin; evaluation of the serum antihyaluronidase and antistreptocolysin levels; complete blood counts; serum protein determinations; urinalysis; blood sugar determinations, and serologic tests were made. Although search for foci of infection revealed mild evidence of such foci in two cases, in none did the focus seem responsible. Other treatments tried in these six cases were fever therapy, consisting of four or five bouts, and systemic administration of penicillin and of aureomycin. In five of these cases systemic treatment with chloramphenicol was not helpful. In one case, after two weeks of chloramphenicol therapy, with a total dose of 42 Gm. of the drug, the uveitis quieted, but seven days after cessation of chloramphenicol therapy, the other, previously uninvolved eye showed uveitis. This condition did not respond to subsequent chloramphenicol therapy. In the remaining four

cases of uveitis, all studies gave negative results except for a positive cutaneous response for brucellergin. In none of these eyes did chloramphenicol appear to have any significant influence in the course of the disease.

HERPES ZOSTER OPHTHALMICUS

Sixteen eyes have been treated to date. Four showed corneal lesions, uveitis and involvement of the lids and skin prior to onset of chloramphenicol therapy. Two had keratitis, uveitis and secondary glaucoma prior to institution of chloramphenicol therapy. In all six cases, four to five days of systemic aureomycin therapy had been given. The ocular complications developed during aureomycin therapy. In another case there was corneal involvement in addition to the cutaneous lesions, and in nine others there was involvement of the lids, but not of the cornea or uveal tract, at the time therapy was instituted.

In all four cases in which fresh cutaneous lesions, severe uveitis and corneal lesions developed during the 72 to 96 hours of aureomycin therapy, there was definite improvement in the cutaneous lesions and severity of the ocular complications within 48 hours after institution of chloramphenicol therapy. Of the two cases with secondary glaucoma, the eye in one quieted with chloramphenicol therapy, but the eye in the other, although improved, still had low grade uveitis and secondary glaucoma, which responded subsequently to systemic use of cortisone (17-hydroxy-11-dehydrocorticosterone).

The one eye with only corneal involvement at the time of institution of chloramphenicol therapy subsequently quieted without advance of corneal lesions or the appearance of any other complications. The total dose employed in any case varied from 11 to 60 Gm. Local therapy was also used in each case.

Of the nine cases in which there was no ocular involvement and no other antibiotic had been given prior to chloramphenicol, fresh vesicles and progression of the cutaneous lesions occurred after beginning of therapy in only one. The progression of these lesions continued for four days. No ocular complications developed in this case. However, in four of this group of nine cases corneal lesions appeared, in three of which they were complicated by uveitis. All the lesions subsided eventually, with excellent visual results. In only one case did the acute pain not subside within 48 hours after onset of therapy. In the others the pain was fairly well controlled by the antibiotic therapy without sedation.

It is difficult to evaluate an agent in the treatment of herpes zoster. The course of the disease is variable. Complications do not always occur, and some patients do well with only supportive and symptomatic therapy. Nevertheless, certain observations can be made from these 16 cases: 1. Progression of cutaneous lesions occurred in only one of nine fresh cases after beginning of therapy with chloramphenicol. 2. Ocular complications (uveitis and/or keratitis) occurred in four of nine fresh cases during therapy with chloramphenicol. 3. All these complications subsided without a protracted course. 4. Pain was ameliorated by therapy in all but one case.

The general impression from observations in this series is that chloramphenicol lessens the severity of, but does not completely arrest, the disease. The drug is not always successful even when given early in the onset of the disease. Chloramphenicol was tolerated better than aureomycin by these patients. It may be that the com-

bination of aureomycin and chloramphenicol is more efficacious than chloramphenicol alone, but the data in this series are inadequate to evaluate that possibility properly.

INTRAOCULAR INFECTION

In six cases of penetrating intraocular foreign bodies systemic chloramphenicol therapy alone was instituted in an effort to prevent the development of secondary infection. In none of these cases did secondary infection occur. In all the cases the foreign body was successfully extracted.

Six eyes in which intraocular infection developed after either a perforated foreign body injury or an operation were treated with chloramphenicol. In every instance penicillin and streptomycin or penicillin and aureomycin had been used prior to the institution of chloramphenicol therapy. In two eyes the infection showed definite improvement within 48 hours after institution of chloramphenicol. In a third eye definite improvement was noted four days after institution of chloramphenicol therapy. In this eye secondary glaucoma developed from the resulting synechias and was controlled subsequently by iridectomy. Two eyes had a resultant visual acuity of 6/20. Vision in the third eye was limited to perception of hand movements. Three eyes were not benefited. Cultures of the cul-de-sacs were sterile from every one of the successfully treated eyes, and there was no opportunity of culturing the intraocular contents. However, cultures from the enucleated eyes revealed P. aeruginosa in one, Bacillus subtilus in one and a mixture of P. aeruginosa, Proteus vulgaris and hemolytic Staph. aureus in the third. Only the P. aeruginosa organisms of the last eye were sensitive to chloramphenicol.

DACRYOCYSTITIS

In one case of acute dacryocystitis the condition was treated with systemic and local use of chloramphenicol; in another, with a combination of penicillin and chloramphenicol. The organisms were Pneumococcus and Staph. aureus, respectively. In both instances the condition quieted within three days, but incision and drainage were necessary. The nasolacrimal ducts were patent after the inflammatory reaction disappeared. In four cases of chronic dacryocystitis with mucopurulent discharge the lacrimal sac was irrigated with chloramphenicol solution in a concentration of 2.5 mg. per cubic centimeter, with clearing in all cases. The organisms were identified as Esch. coli in two cases, H. influenzae in one and a mixture of Pneumococcus and Esch. coli in the fourth. In three of these cases the condition recurred, with the same organism, after one irrigation. The interval in which the eye remained clear after the initial irrigation varied from one to two weeks. The second irrigations, continued daily thereafter for two to four treatments, cleared the condition in all cases. However, in one of the cases a sensitivity to chloramphenicol developed so that irrigations had to be stopped. In the other cases the lacrimal sac has remained free from subsequent infection for two to four months with local instillation of chloramphenicol solution four times daily. In three other cases the infection cleared with daily irrigation but recurred at varying intervals in spite of continued therapy.

In a case of recurrent dacryocystitis with a draining fistula the condition failed to clear completely with penicillin, aureomycin, terramycin or chloramphenicol

therapy. Although purulent discharge could be obtained readily from the fistula, no organism was ever cultured. The inflammatory reaction did quiet with chloramphenicol therapy but flared, although the drug was continued.

MISCELLANEOUS CASES

In a case of optic neuritis in which a complete neurologic survey and analysis of the spinal fluid showed no evidence of multiple sclerosis, improvement of visual acuity, from 6/15 to 6/9, occurred within three days after the beginning of systemic administration of chloramphenicol. There were definite improvement in the appearance of the nerve head within four days and a striking decrease in the area of relative central scotoma. The condition had existed for two weeks prior to the commencement of this therapy. Therapy was stopped after five days (16 Gm.). The patient's visual acuity has remained at 6/9 for the subsequent four months, with neither further improvement nor regression. This case may represent a favorable response in a type of infectious optic neuritis, or it may be simply an instance of spontaneous recovery from a nonspecific neuritis.

In three other cases of optic neuritis and in two of retrobulbar neuritis the disease was uninfluenced in its course by this drug.

One patient with toxoplasmosis had been treated unsuccessfully with penicillin, aureomycin and pituitary adrenocorticosterone (ACTH) and also failed to respond to systemic administration of chloramphenicol.

A patient with orbital infection following an exenteration for whom cultures of the area of infection showed P. aeruginosa failed to respond to penicillin and aureomycin and did not show any improvement with local and systemic use of chloramphenicol. Bacterial sensitivity tests had suggested a slight effectiveness of chloramphenicol.

TOXIC SIGNS

Ten of the patients complained of a bitter taste in the mouth after the large initial dose, but only one instance of severe nausea was encountered. Four other patients complained of nausea on the first day of therapy which disappeared on subsequent days. No case of vomiting occurred. One patient had a serum sickness type of reaction. One eye with chronic dacryocystitis showed sensitivity to chloramphenicol solution, locally instilled, and in an eye with a corneal abrasion follicular and conjunctival edema with itching developed during local prophylactic treatment with chloramphenicol solution.

In only one case was it necessary to stop the use of the drug because of the patient's gastrointestinal disturbance. Blood counts showed no significant change in any of the patients. No patient complained of diarrhea, although three patients had abdominal cramps.

Two patients exhibited white plaques on the oral mucosa while receiving the drug. Cultures from these areas in one case showed Candida albicans.

It is apparent from these data that a wide variety of forms of conjunctivitis can be successfully treated by local application of chloramphenicol in solution. The drug may be successfully employed in various forms of keratitis. All corneal lesions were treated by local and systemic administration. The favorable results in dendritic keratitis are noteworthy. There is experimental evidence that chloramphenicol will inhibit the development of an experimentally induced herpes simplex of the rabbit cornea.

Special attention should be paid to the results in herpes zoster ophthalmicus. These favorable results do not prove that herpes zoster ophthalmicus will respond to chloramphenicol in all cases, but they suggest that the drug is helpful. All of these cases may have been of the mild sort, but in several of them uveitis and corneal lesions quieted during the medication; it is also significant that fresh vesicles developed in only one case after institution of the therapy.

Of great importance is the ability of this drug to penetrate from the blood stream into the intraocular structures. In three cases intraocular infections were definitely quieted after failing to respond to other antibiotics. It is true that in three cases the condition failed to respond to this agent, as well as to others. In these cases it may be that the infection was too virulent, even if the organism was susceptible to chloramphenicol. Perhaps one should consider intravitreal injections in the control of such overwhelming infections.

Recent studies have revealed that systemically administered chloramphenicol will penetrate into the rabbit eye. To determine whether these results could be applied to human eyes, analyses of chloramphenicol in the aqueous and the vitreous

TABLE 3.—*Intraocular Penetration of Orally Administered Chloramphenicol in Human Eyes* *

Patient	Ocular Condition	Concentration, Micrograms/Cc.		
		Blood	Aqueous Humor	Vitreous Humor
M. P.†	Optic nerve atrophy	30	5	5
J. McN.†	Malignant melanoma	30	5	..
A. A.‡ (3 hr.)	Malignant melanoma	26	8	5
A. A.‡ (24 hr.)	Malignant melanoma	18	10	..
V. G.†	Absolute glaucoma	30	30	15
R. N.†	Absolute glaucoma	28	25	..
L. E.§	Occlusion of central retinal artery	50	15	..
P. S.‖	Uveitis	13	12	..

* Miss Anna C. Nichols gave technical assistance in the chloramphenicol analyses.

† Specimens were withdrawn from these eyes and from the blood stream three hours after oral administration of 3 Gm. (12 kapseals®) of chloramphenicol, just before the eyes were enucleated.

‡ Chloramphenicol was administered in a dosage of 3 Gm. initially and 0.5 Gm. every four hours for 24 hours. Specimens were withdrawn three hours and 24 hours after beginning of administration of the drug.

§ Specimens of aqueous humor and blood were withdrawn one hour after oral administration of 3 Gm. of chloramphenicol.

‖ Chloramphenicol was administered in a dosage of 3 Gm. initially and 0.5 Gm. every four hours for four days. Specimens were withdrawn on the fourth day, after 15 Gm. had been administered.

humor were made in various human eyes after systemic administration of chloramphenicol. The results are presented in table 3.

It is evident that chloramphenicol will penetrate and the level be maintained in the aqueous humor and the vitreous humor of the human eye in the dose used in this study. It is true that most of these eyes were about to be enucleated and could not be considered normal. However, it is unlikely that the blood-aqueous barrier has been altered from normal in eyes with a malignant melanoma or occlusions of the central retinal artery, and it is quite possible that these values are consistent with those to be found for normal eyes. The extremely high levels in the aqueous humor of eyes with absolute glaucoma suggest that there has been a great increase in the permeability of the blood-aqueous barrier in such eyes. There had been no local miotic therapy for 24 hours prior to the time of withdrawing specimens for analysis.

With these data and other information derived from the available literature,[6] it is evident that most ocular infections of bacterial origin can be controlled by antibiotics presently available. Several such conditions of viral origin can also be treated successfully. Wherever possible, the ophthalmologist must be guided in his choice of antibiotic by culture and sensitivity studies. When there are multiple choices, he can use the drug which is easiest to administer, the least toxic and the cheapest. The initial dose must be adequate to prevent the development of organism resistance. If no improvement occurs in 48 to 72 hours with the antibiotic selected, change to another antibiotic should be made. Therapy should be continued at least 48 hours after the infection has been controlled. The toxic reactions must be kept in mind constantly.

Favorable results may be increased in number by combining various antibiotics in therapy. Such treatment will usually result in greater effectiveness and less toxicity. However, this is not always the case, as it has been demonstrated that chloramphenicol may have an antagonistic action on the early bactericidal effects of penicillin on enterococci.[7] Further studies along this line will be helpful.

SUMMARY

1. Chloramphenicol solution, in a concentration of 2.5 mg. per cubic centimeter of water, has been used successfully in the local therapy of a variety of forms of conjunctivitis and dacryocystitis.

2. Chloramphenicol systemically and locally administered was helpful in various forms of keratitis but was not of value in uveitis.

3. Chloramphenical systemically administered resulted in clearing of intraocular infection in three cases.

4. Fifteen patients with herpes zoster ophthalmicus did well while receiving chloramphenicol systemically. No conclusion can be drawn concerning the specific response of this disease to chloramphenicol, as the course is notoriously variable. The results in this small series are only suggestive, not conclusive.

5. Systemically administered chloramphenicol penetrates into the intraocular fluid of the human eye, and the level is maintained on the dosage schedule used in these studies.

---

6. Bellows, J. G.: Modern Management of Ocular Infections, Am. J. Ophth. **33**:909, 1950. Burstein.[4c] Finlay, A. C.; Hobby, G. L.; Pan, S. Y.; Rontien, J. B.; Regria, P. P.; Seeley, D. B.; Shull, G. M.; Sobin, B. A.; Solomons, I. H.; Vinson, J. W., and Kane, J. H.: A New Antibiotic, Science **111**:85, 1950. Hendricks, F. D.; Greaves, A. B.; Olansky, S.; Taggart, S. R.; Lewis, C. N.; Landman, G. S.; MacDonald, G. R., and Welch, H.: Terramycin in the Treatment of Venereal Disease, J. A. M. A. **143**:4 (May 6) 1950. King, E. O.; Lewis, C. N.; Welch, H.; Clark, E. A., Jr.; Johnson, J. B.; Lyons, J. B.; Scott, R. B., and Cornely, P. B.: Clinical Observations on the Use of Terramycin Hydrochloride, ibid. **143**:1 (May 6) 1950. Leopold.[1a] Lepri, G.: Experimental Study on the Efficiency of Different Substances in Retarding the Absorption of Penicillin Introduced into the Subconjunctival Spaces, Brit. J. Ophth. **34**:425, 1950. Long, P. H.: The Use and Impact of Antibiotic Therapy, Pennsylvania M. J. **53**:209, 1950. Long, P. H., Jr.; Chandler, C. A.; Bliss, E. A.; Bryer, M. S., and Schoenbach, E. B.: The Use of Antibiotics, J. A. M. A. **141**: 315 (Oct. 1) 1949. Thygeson and Hogan.[4f] Tucker and others.[2h] Vogel, A.; Leopold, I. H., and Nichols, A.: Neomycin: Ocular Tissue Tolerance, to be published.

7. Incompatible Antibiotics, editorial, J. A. M. A. **143**:816 (July 1) 1950.

INVESTIGATION OF VISUAL SPACE

The Blumenfeld Alleys

LE GRAND H. HARDY, M.D.
GERTRUDE RAND, Ph.D.
AND
M. CATHERINE RITTLER, A.B.
NEW YORK

THE PROBLEM of space perception is an old and important problem in visual physiology. It is assumed that there is some relationship between the world we live in and our visual sensations. But it is known that there is not a one-to-one correspondence between physical stimuli and visual sensation. One unit of physical measurement does not cause one unit of perception. Our sensations do not change directly with the physical change of the stimuli causing them. Many inconsistencies and paradoxes arise when we try to correlate our perceptions with the physical configuration of the stimuli. Until recently it seemed such a correlation was impossible. The essence of Luneburg's "Mathematical Analysis of Binocular Vision" [1] is that there exists such a basic correlation limited to the assignment of apparent size to line elements and that if this concept proves true much valuable information regarding our space perceptions may be derived mathematically and subjected to experimental testing.

To develop such a thesis a differentiation of "physical space" from "visual space" was necessary. "Physical space" is a measurable, engineering space of the outside world. It is the space in which houses, bridges, roadways and railways are mapped and built with great precision. It is the space with which the engineer is constantly concerned.

"Visual space" is the immediate instantaneous impression we have of our environment as a three dimensional manifold; the immediate impression we have of objects about us in relative terms: farther-nearer; larger-smaller-equal.

The necessity for such a differentiation arises from certain well established phenomena in visual optics. Important among these are the following:

Dr. Rudolf Luneburg and Dr. Paul Boeder acted as mathematical consultants in these studies.

The work was carried out under Contract N6onr-27119; Project Designation Number NR-143-638.

Reproduction in whole or in part is permitted for any purpose of the United States Government.

From the Knapp Memorial Laboratory for Physiological Optics, Institute of Ophthalmology, Columbia University College of Physicians and Surgeons.

1. Luneburg, R. K.: Mathematical Analysis of Binocular Vision, Princeton, N. J., Princeton University Press, 1947.

1. The sensed size of objects at different distances does not follow the visual angle law, but is in some way modified by the distance to which they are projected. However, the sensed size of objects is by no means proportional to their physical size and their physical distance, particularly at great distances. (The physical size of the moon cannot be sensed; a star distance cannot be sensed; the sky appears not as an infinite space but as a finite curved dome; a man does not appear smaller at 40 feet than at 10 feet.)

2. Physically straight lines in the frontal plane appear as curved lines, and certain physically curved lines appear straight (the horopter experiments of Helmholtz [2] and Hillebrand [3]).

3. Lines sensed as parallel, straight and perpendicular to the frontal plane are physically not parallel, straight or perpendicular to that plane (Hillebrand's alley experiment).

4. Alleys of lights set to appear parallel and perpendicular to the frontal plane do not coincide with alleys set to appear "equidistant" (Blumenfeld's alley experiments [4]). Hence, in visual space "equidistant" and "parallel" do not mean the same thing.

5. Markedly different physical configurations of stimuli arouse the same sensation. Ames's "distorted rooms" [5] is an elegant example of the difference between "physical" and "visual" spaces.

In dealing with this problem, one is forced to conclude that if physical space is Euclidean in its nature (at least in the range wherein our human stereopsis functions) visual space cannot be, and Luneburg was led to consider the possibilities other (non-Euclidean [6]) geometries held for finding a "psychometric," i. e., a coordination of the sensed points of a visual sensation to the points of a geometric manifold such that the apparent distance of any two sensed points is always proportional to the geometric distance of the correlated points. He was led to conclude that the geometry of the visual space is non-Euclidean in nature and corresponds closely to the hyperbolic geometry of Bolyai and Lobachevski. Utilizing this concept, Luneburg was able to clarify considerably the apparently inconsistent and paradoxical phenomena we have listed above (Helmholtz, Hillebrand, Blumenfeld and Ames). In addition, the Weber-Fechner law is very simply derived mathematically from this information.

The problem is of great importance in art, architecture, ophthalmology, industry and war. It was particularly in reference to the determination of the K constants

2. Helmholtz, H. L. F.: Physiological Optics, edited by J. P. C. Southall, Rochester, N. Y., Optical Society of America, 1925, vol. 3, p. 318.

3. Hillebrand, F.: Theorie der scheinbaren Grösse bei binocularem Sehen, Denkschr. d. k. Akad. d. Wissensch. Math.-Naturw. Klasse **72**:255-307, 1902.

4. Blumenfeld, W.: Untersuchungen über die scheinbare Grösse im Sehraume, Ztschr. f. Psychol. u. Physiol. d. Sinnesorg. **65** (Abt. 1):241-404, 1913.

5. Ames, A., cited by Luneburg.[1]

6. "Non-Euclidean" is a term used by Gauss to describe a system of geometry different from Euclid's in that the Fifth Postulate regarding parallelism was not used. Bolyai, in Hungary, and Lobachevski, in Russia, had each developed a non-Euclidean system about 1820. Later Riemann, in Germany, and Cayley, in England, developed another system differing radically from Euclid's. In 1871 Klein classified the various systems, giving the names parabolic, hyperbolic and elliptic to the respective systems of Euclid, Bolyai-Lobachevski and Riemann-Cayley.

of a number of observers and a correlation of this factor with their mechanical abilities that the naval contract under which this work has been carried out was offered. Eight empirical methods of studying the visual space of an observer have been formulated. This report deals with the first. Since Blumenfeld [4] had acquired a great mass of data which most strongly indicates the non-Euclidean nature of visual space, it was decided first to set up and repeat his "parallel" and "equidistant" alley experiments in the hope of finding a simple method of determining the individual constants of different observers. (Blumenfeld had not used any non-Euclidean analysis of his results—they were simply paradoxical.)

At the time our experiments were begun (late in 1947) Luneburg's analysis had indicated that at least two personal constants characterized each observer. These were sigma (σ)[7] and K, which should be determinable experimentally and which should yield a description of the sensed space of the observer. Sigma is a constant determining the sensitivity of depth perception compared with the perception of lateral size and thus must be related to the interpupillary distance of the observer. Since the threshold of depth perception is considerably smaller than the threshold of size, sigma (σ) will be considerably greater than 1. The constant K determines the geometric character of the visual space and thus must be considered as a significant psychological constant which is a characteristic for an individual observer (analogous to his myopia, hypermetropia, astigmatism, aniseikonia, etc.). It is of importance for the relation of sensory judgment of size to physical size. Though the two will never be identical, one finds that the best approximation of physical size by sensory estimation is represented by the case $K = -1$. Indeed, in this limiting case, infinite distances are possible in the visual space. Thus, we conclude that the visual estimation of an observer agrees with physical size the nearer -1 the constant K is found. The possibility that a high correlation of mechanical abilities (in drivers, pilots, steersmen, gun sighters, etc.) to the values of K could be established was a principal motivation in undertaking this study.

THE BLUMENFELD ALLEYS

Hillebrand [3] in 1902 had demonstrated that alley walls, outlined by black threads against a white background, which appeared to an observer as parallel, actually converged toward the eyes and were not straight, but slightly curved. In these experiments no differentiation was made between the apparent parallelism and the apparent equidistance of the walls of the alley. Blumenfeld [4] in 1913 modified Hillebrand's procedure by giving in separate experiments the instruction to form the alley walls so that they appeared parallel and so that they appeared equidistant. He found with seven observers that the alleys so formed were not the same. The apparently equidistant walls have a wider lateral extent and a different curvature

7. Luneburg (The Metric of Binocular Visual Space, J. Optic. Soc. America **40**:627-642 [Oct.] 1950) defined the parameters of visual space as $f(\gamma)$ and K instead of σ and K. In doing this, he abandoned the necessity of always considering σ as a constant. He defines $f(\gamma)$ as a "non negative function of γ which increases monotonically if γ decreases from positive values to $\gamma = 0$." If future experiments indicate that σ is a constant, then $f(\gamma)$ may be specified as $2e^{-\sigma\gamma}$.

than the apparently parallel walls. Blumenfeld worked in a darkroom, using as stimuli tiny gas flames. Six distances were employed, ranging from 400 to 80 cm. from the eyes. The work was done both with the eyes at the level of the lights and with the eyes 7 cm. above the height of the flames.

According to Luneburg's mathematical analysis of such alleys formed with binocular vision, the condition in which the apparently equidistant alley walls lie outside the apparently parallel walls occurs when the personal constant K of the observer assumes a value less than zero. This, mathematically, means that the metric of the observer's visual space corresponds to hyperbolic geometry. If the two types of alley had been identical, K would have had a value of zero and the metric of his visual space would have been Euclidean. If, on the other hand, the apparently equidistant walls had occurred inside the apparently parallel walls, the personal constant K would have been greater than zero and the metric of his visual space would have corresponded to elliptic geometry. According to Blumenfeld's results as interpreted by Luneburg, therefore, the metric of the visual space of these observers is usually hyperbolic. The second personal constant, σ, can also be derived from the experimental data of these alleys.

EXPERIMENTAL INVESTIGATION

Apparatus.—An alley board, 20 feet (6 M.) long and 4 feet (122 cm.) wide, was constructed which permitted the experimental formation of alleys whose walls, one to the right and one to the left of the median plane, appear to the observer as parallel (Blumenfeld's Parallel Alley), and of alleys whose walls appear to the observer as equidistant (Blumenfeld's Distance Alley.) The walls of the alleys were delineated by minute points of light, resembling stars, spaced at 10 intervals through a distance of 500 to 50 cm. from the eyes. In order to eliminate as far as possible all external clues, the experiments were conducted in a darkroom.

The stimuli were 20 small General Electric lamps, 2.5 volts, 0.27 ampere. Ten lamps were used to form the alley wall on each side of the median plane. The lamps were connected to a transformer with rheostat control, so that they produced tiny points of light seen as stars, the intensity of which was so low that there was no perceptible surrounding illumination. They were mounted on small rectangular blocks of wood with the luminous filaments 3.5 cm. above the base of the mounting. Ten experimental distances were used: 500, 387, 300, 232, 180, 139, 108, 83, 65 and 50 cm. from the nodal points of the observer's eyes. These distances will be called stations 1 to 10, respectively. At station 1, 500 cm. from the eyes, two lamps were fixed in position, one 35 cm. to the right and the other 35 cm. to the left of the median line of the alley board. These fixed lamps served as the standard against which the pair of lights at each nearer station were to be adjusted (*a*) to form an alley with apparently parallel walls or (*b*) to form an alley such that the lateral space between the fixed pair of lights and that between each other pair appear equal. In fixing the position of the standard lights at the most distant station, we are following Blumenfeld's procedure.

To aid in the lateral adjustment of the lights in the darkness, nine metal strips were fastened across the width of the alley board. When a lamp mounting was in contact with the edge of any strip, the filament was located at the desired experimental distance. Two experimenters, one on each side of the alley board, were easily able to move the lamp mountings along the metal strips as directed by the observer.

Only binocular observations were made. The observer's head was fixed in a three way adjustable head rest with his nodal points, taken as 7 mm. behind the cornea, the indicated distance from the lamp filaments. The height of the eyes was set at 5.5 cm. above the filaments in order to avoid interposition of the lights at different distances and to prevent as far as possible annoyance from double images. The median plane of the observer was alined by parallax to the median line of the alley board. For this adjustment two additional lights placed 2 M. apart on the median line served as stimuli.

Procedure.—To form alleys with apparently parallel walls, the pairs of lights of stations 1 and 2 were first connected, and those of station 2 were adjusted laterally under the direction of the observer until they appeared to approach him as parallel walls originating from station 1. The pair of lights of station 3 were next added to continue the formation of apparently parallel walls; then the lights of station 4, and so on. This procedure conforms to Blumenfeld's technic for setting the "simultaneous" parallel alley. During the formation of the alley and after the entire alley had been constructed, the observer was allowed to request the readjustment of any light. Measurement of the position of the lamp filaments was made only after the observer had retired to an adjoining room.

To form alleys whose walls appeared equidistant, the lights of stations 1 and 2 were connected and those of station 2 adjusted under the observer's direction until he was satisfied that the lateral spaces between the pairs of lights at the two stations appeared of equal size. The lights of station 2 were then disconnected; those of station 3 were connected and adjusted under direction until the distance between this pair of lights appeared equal to that between the fixed pair of station 1. The experiment continued in this way with the adjustment of each successive pair of lights in comparison with the fixed pair of station 1. This procedure conforms to Blumenfeld's technic for setting the "successive" distance alley. In this case no readjustment of the lights was permitted after each station was set and the observer did not see the entire equidistant alley he had formed.

The specific instructions given the observer were in general similar to those used by Blumenfeld. They are as follows:

"This is an experiment dealing with space perception. We know one does not always perceive objects in space where they actually are in physical space, or to be of their actual physical size. We want to measure some of these differences.

"In the first experiment we shall show you some small lights which we shall arrange under your direction so that when you look down between them they appear to you to form straight, parallel lines of light. We wish you to think not of where the lights actually are, but merely of how you sense them. When they are all arranged, we want you to be able to say that these straight lines of lights as you see them could never, if extended, meet at any distance in front of you or at any distance behind you, that is, that they form walls that appear to you as parallel walls that appear neither to converge nor to diverg[illegible]"

To familiarize the observer with the observation, a trial run utilizing only stations 1, 3, 5 and 8 was made, no measurements being taken of this trial. The instructions continued:

"In the second experiment we shall give you two pairs of lights at a time. The position of one pair will be fixed. We want you to direct us to move the lights of the other pair so that the lateral distance between them appears to you the same as that between the first pair. We want you to make an immediate, instantaneous judgment of whether the distance between the lights of the second pair is greater or smaller than or equal to that between the first pair. Do not think in terms of physical units of distance between the lights, for example, inches or centimeters. Just direct us in adjusting them until you immediately sense the two pairs of lights as being the same distance apart."

Again a trial run utilizing only stations 1 and 3, 1 and 5, and 1 and 8 was made, again without measurements. After these preliminary observations, the experiment continued with the formation of the complete parallel and equidistant alleys in that sequence. The usual procedure was to give a second trial of each alley on the same day and to repeat the series on a second day.

Results.—In chart 1 are presented the results for two observers, both of whom were experienced in making visual judgments but neither of whom had prior experience with this type of experiment. In *A* are shown for one of these observers three trials of the apparently parallel alley (dash lines); in *B*, three trials of the apparently equidistant alley (solid lines), each made after the formation of a parallel alley, and in *C*, the average parallel and equidistant alleys formed by this observer. In *D* is shown for the other observer a single formation of the two types

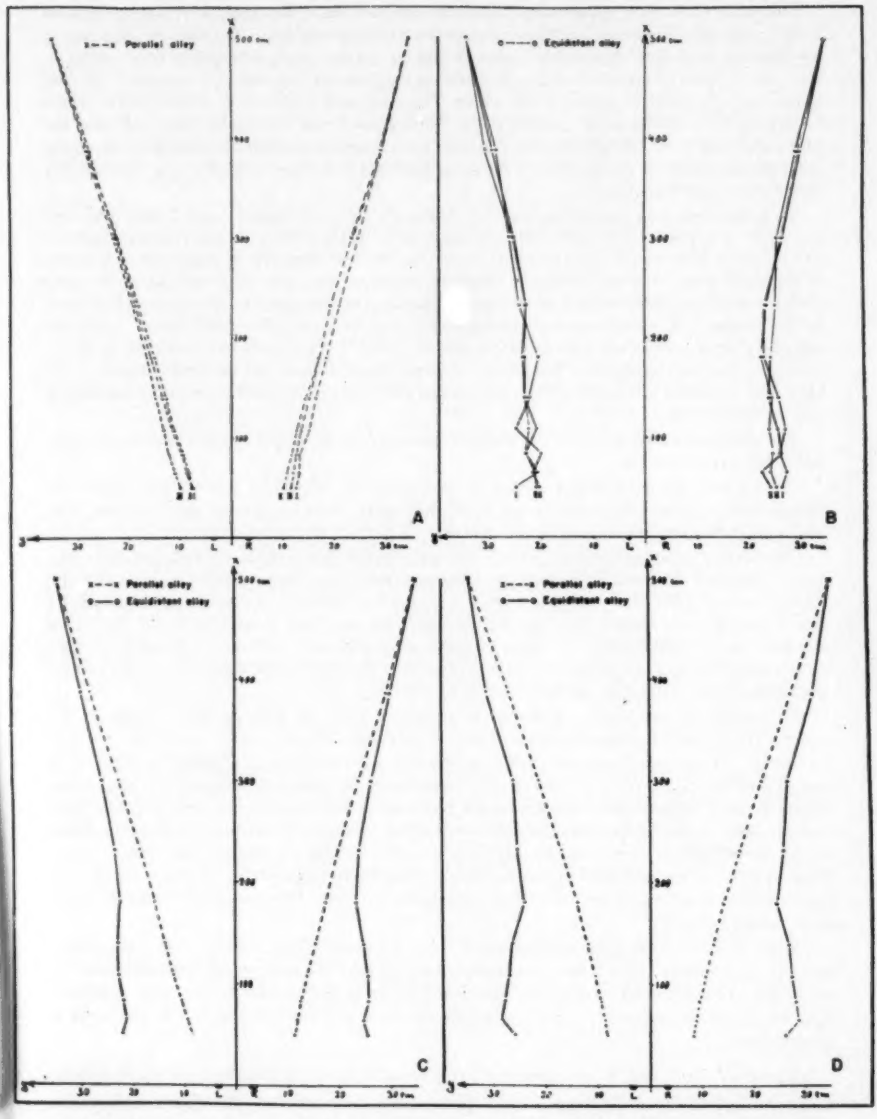


Chart 1.—Examples of parallel and equidistant alleys formed by observers whose curvature of visual space is shown by the alley experiment to be that of hyperbolic geometry.

A, three trials of parallel alley, *B*, three trials of equidistant alley, *C*, average parallel and equidistant alleys for one observer; *D*, a single trial of the alleys for another observer (right and left walls of alley averaged).

of alley. In this, and in the following cases presented, the alley walls formed on the right and left sides of the median line were averaged, since only average values are needed for purposes of computation of the personal constants. However, to simulate the appearance of an alley in the charts, the average wall is drawn on each side of the median line. Unimportant asymmetries on the right and left sides are thus not shown.

The results for these two observers are in general agreement with those of Blumenfeld's observers in that the equidistant alley lies outside the parallel alley. The curvature of the visual space is, then, according to Luneburg's analysis, that of hyperbolic geometry, K having a value less than zero. Among our observers

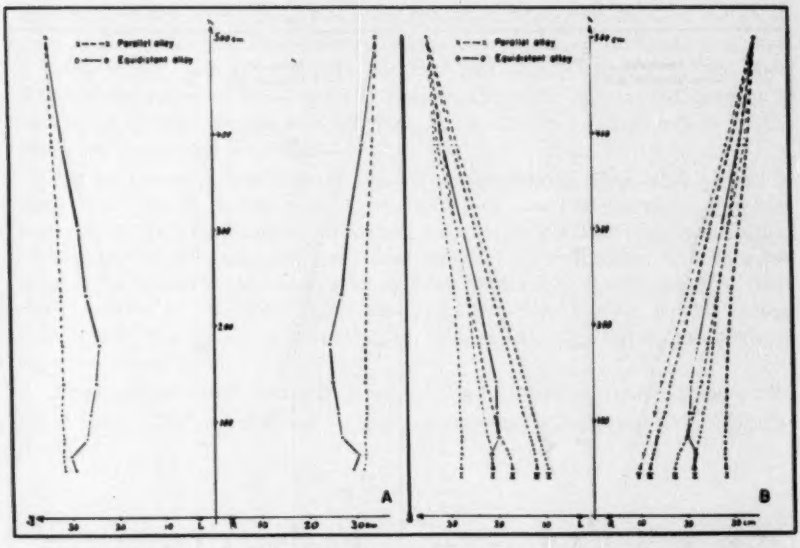


Chart 2.—Examples of parallel and equidistant alleys formed by observers who experienced difficulty in dissociating physical and sensory parallelism.

A, alleys formed by one observer with the initial instructions (average of two trials).

B, for another observer, average equidistant alley (five trials) and five successive trials of parallel alley. Trial 1 was set with the initial instructions; trials 2 to 5, were set after a discussion of the difference between physical and sensory parallelism. This illustrates how instruction and experience modify the perceptual form of the alley for some observers.

whose results were adequate for computation of the personal constants of Luneburg, eight were of this type.

The situation was not, however, so simple with all observers. For example, difficulty was experienced with some who tended to set the walls of the parallel alley not to appear parallel but, rather, as they would appear if they were actually parallel. In these cases the alley which was formed approximated fairly closely physical parallelism and was wider than the equidistant alley. Five observers were of this type. According to Luneburg's analysis, the curvature of the visual space of these observers is that of elliptic geometry, K being greater than zero.

Three of these observers, however, after the alleys had been measured, were asked how railroad tracks appear to them. All three admitted that parallel lines of tracks appear to converge in the distance, and that the parallel alleys they had formed appeared to converge in the same way. After this discussion, the instructions were repeated and further trials were made. Each successive trial resulted in alleys of increasingly greater convergence toward the eyes. Our belief is that, at least in these three cases, the curvature of the visual space was that of hyperbolic, not elliptic, geometry; that the observer in the initial trials had been unable to dissociate physical and sensory parallelism. An average of the results obtained before and after the discussion of the situation would not be representative unless the initial trials were discarded.

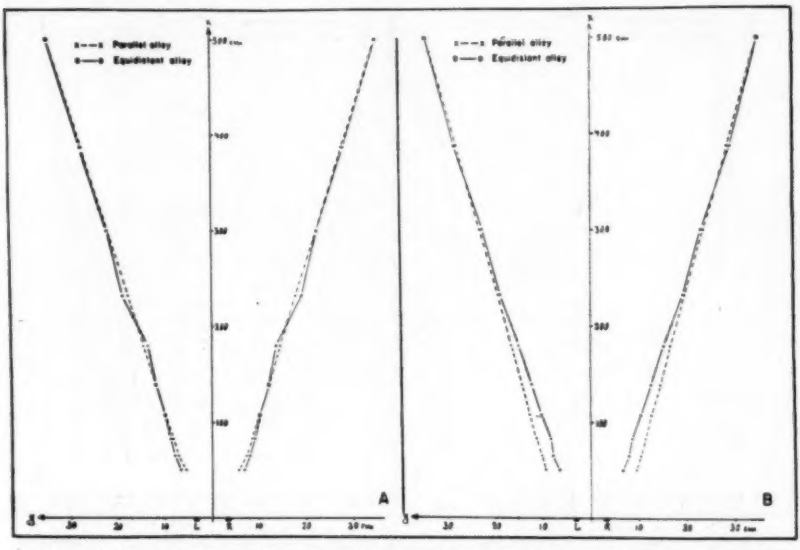


Chart 3.—Examples of parallel and equidistant alleys formed by two observers who had had training in art and the portrayal of vanishing point and central projection perspective.

In chart 2 *A* is presented for one of these three observers the parallel and the equidistant alley originally formed (average of two trials). In *B* of this figure is shown for another of these observers each of five trials of the parallel alley and the average equidistant alley (five trials). In this case only trial 1 was formed with the initial instructions. After the discussion of the appearance of railroad tracks, trials 2 to 5 were made without further comment on the part of the experimenters. On the completion of the fifth trial of the parallel alley the observer volunteered the statement that this was the best he had done, that this alley appeared most nearly parallel. Throughout the series the equidistant alley showed no consistent changes.

It is possible that this type of response might have been avoided, at least in part, had we given different initial instructions. For example, the observer might

have been shown in advance an alley that was physically parallel and the apparent convergence in the distance discussed with him. The direction to set the alley so that the walls appeared parallel could then have been given. This type of instruction would have followed Hillebrand's, but not Blumenfeld's, procedure. Even with these instructions, however, we doubt if a complete dissociation of physical and sensory parallelism would have been obtained with all observers.

A third type of observer formed apparently parallel and equidistant alleys that were approximately identical. There were two observers of this type. Both had had training in art and the portrayal of vanishing point and central projection perspective, and by some learned formula set both alleys so that their walls converged almost directly to the eyes. The results for these observers are shown in chart 3, *A* and *B*. According to Luneburg's analysis, the curvature of the visual space in these cases may be considered to approximate that of Euclidean geometry, K being slightly less than zero in one case and slightly greater in the other. Whether the metric of visual space is Euclidean in these cases would have to be determined by other experiments which do not involve an acquired technic for the estimation of size and parallelism.

The experimental results of the equidistant and parallel alleys when plotted in cartesian coordinates (x, y), as in charts 1 to 3, give some evidence of the geometric character of the visual space. However, in order to facilitate the mathematical investigation of the relationship of visual space to physical space, Luneburg has suggested a special bipolar system of angular coordinates (γ,ϕ,θ) which is more closely related to the physiological aspects of binocular vision. In this system γ represents the bipolar parallax; ϕ, the bipolar latitude, and θ, the angle of elevation for any point.

An evaluation of the angular coordinates γ_o and ϕ_o [8] for the fixed end point of the alleys (station 1) was obtained for the experimental values x and y by the relationships

$$\tan \gamma_o = \frac{2 x_o}{x_o^2 + y_o^2}$$

and

$$\tan \phi_o = \frac{y_o}{x_o}$$

where x_o and y_o represent the experimental x and y of the fixed end point corrected for the interpupillary distance of the observer. That is, $x_o = \frac{x}{\frac{1}{2}\text{ P.D.}}$ and $y_o = \frac{y}{\frac{1}{2}\text{ P.D.}}$.

It was essential for the evaluation of the personal constants, sigma (σ) and K, that the relationship be obtained between $d\gamma$ and $d\phi$, as it is shown by the equidistant and parallel alleys of the observer. This relationship was found from the graph by drawing the best tangent to the more remote parts of each curve and obtaining the two intersection points on the y axis. These values, corrected for the interpupillary distance of the observer, were called a_D and a_P, respectively.

8. We have assumed that $< \theta = 0$, as a first approximation, although in our experiments the eyes were adjusted slightly above the level of the lights to avoid, as far as possible, double images.

By the use of the preceding relationships, sigma (σ) and K were evaluated by the equations [7]

$$\sigma = \frac{1}{2 \tan \phi_o} \sqrt{a_D a_F}$$

and

$$K = e^{2\sigma\gamma_o} \left(\frac{\sqrt{\frac{a_F}{a_D}} - 1}{\sqrt{\frac{a_F}{a_D}} + 1} \right)$$

In the table are given the values of sigma σ and K for 15 observers whose results were adequate for computation of these personal constants.

Luneburg's Personal Constants σ and K as Determined by the Alley Experiment *

Observer	σ	K
1	9.0	−0.73
2	55.0	−0.63
3	43.0	−0.62
4	20.6	−0.35
5	25.3	−0.23
6	24.5	−0.19
7	45.0	−0.18
8	28.4	−0.18
9	7.1	−0.06
10	11.4	+0.06
11	46.5	+0.17
12	19.4	+0.21
13	60.1	+0.36
14	73.6	+0.37
15	48.5	+0.47

* Values for 15 observers whose results were adequate for computation.

For an evaluation of the constants shown in the table, it should be pointed out that they are based on the average of the results obtained with the original instructions and that in many cases reproducibility was poor. Some observers tended to change the criterion of the judgment of apparent parallelism and equidistance on successive trials of the experiment, often under the influence of the alley previously formed. In some of these the apparently parallel alley was set wider, and in others it was set narrower with repetition, while the equidistant alley was most frequently set wider on successive trials, particularly at the near stations.

It is interesting to note that Blumenfeld also encountered these difficulties. His results are based on a large number of trials, some of which are not listed in his tables and some of which are listed but not included in the average computations. Often he was obliged to discuss the instructions with the observer and to change them before the expected results were obtained. For example, with the type of observer who set apparently parallel walls as they would appear if they were physically parallel, he added, during a discussion of the appearance of lights in a subway, the instruction to set the walls to appear "perpendicular to the frontal plane." His observers were usually required to set a consecutive series of parallel alleys, then a series of distance alleys, then, again, the parallel alley. Frequently he found that

the second group of parallel alleys was set wider than the first group because, he believed, of the influence of the distance judgment. Instances of this type are given in his tables but were not averaged in the results.

CONCLUSIONS

The results obtained have led us, in consultation with Luneburg and Boeder, to conclude that the alley experiment presents insuperable difficulties to practical application. Some of our reasons for this conclusion are as follows: 1. The inability of some observers to follow instructions. For example, the instruction to set the walls of the alley so that they appear parallel often resulted in a setting of the walls as they would appear if they were physically parallel. 2. The tendency of some observers to change their criterion for the judgment of "parallelism" and equidistance" on successive trials of the experiment. 3. The strong influence on these judgments of the prior associations, experience and judgment habits of the observer. This influence was particularly evident with observers who had either mechanical experience or artistic training. For some observers of this type it is obvious that frequent discussions of the criteria employed in making their judgments and many repetitions of the experiments would be necessary before the judgments could be stabilized so that reproducible values of the constants could be obtained.

Our conclusion is, therefore, that the alley experiment is inadequate as a test of the personal constants, sigma (σ) and K, of an observer's visual space because of the effect on the results of preconception, experience and judgment habits of the observer. We are forced to this conclusion in spite of the fact that the apparently parallel and apparently equidistant alleys of Blumenfeld demonstrate, perhaps as clearly as any other spatial phenomenon, that the metric of the visual space is that of non-Euclidean geometry. It is our hope and belief that other procedures can be devised which will present to the observer spatial judgments which are outside the realm of his previous experience and associations. Work is under way with several procedures of this type.

23 East Seventy-Ninth Street

AMBLYOPIA INDEPENDENT OF USUAL ASSOCIATED CONDITIONS

JOSEPH W. HALLETT, M.D.
PHILADELPHIA

THE ASSOCIATION of amblyopia ex anopsia with strabismus or anisometropia is well known. That type of amblyopia constitutes no part of the considerations in the present paper. There is, however, a type of amblyopia which is unassociated with present or past strabismus or with anisometropia. In 1944 I[1] had the opportunity to study a number of soldiers with the latter type of defective vision. For want of a better name, the term "unexplained amblyopia" was applied to this condition. The redundancy in such a name is obvious, for by definition amblyopia is "poor vision which cannot be explained on any organic basis"; but the term was used only in an effort to emphasize the distinction between this type of amblyopia and the much commoner form, amblyopia ex anopsia.

The study in 1944 included 42 consecutive cases, representing 0.45 per cent of about 9,300 new patients referred to a large station hospital for ophthalmologic study and treatment during that year. In 1948 and 1949 a similar opportunity for investigation presented itself in an outpatient clinic of the Veterans Administration. The purpose of this paper is to extend the observations made in the earlier study by the addition of five consecutive cases (0.21 per cent), occurring among approximately 2,400 new patients referred to the ophthalmologic clinic. Thus, of a grand total of 11,700 patients, 47 (0.4 per cent) were considered properly included for study.

More or less arbitrarily, a best obtainable visual acuity of less than 20/40 was considered as amblyopia. This acuity was adopted because it was the minimum visual requirement for general military service at the time this study was initially undertaken. It also represents the average minimum visual standard for drivers of motor vehicles in most states and was recommended for universal adoption by the American Medical Association's Committee on Visual Standards for Operating Motor Vehicles.[2]

The question of the amount of anisometropia beyond which amblyopia may result had to be considered. Duke-Elder[3] claimed that each 0.25 D. of difference between the refraction of the two eyes causes a 0.5 per cent difference in size between the two retinal images, and a difference of 5 per cent is probably the limit which can be tolerated. This would make an anisometropia of 2.5 D. the dividing line, and it was so adopted for this study.

1. Hallett, J. W.: Unexplained Amblyopia as a Military Problem, Mil. Surgeon **99**:110, 1946.

2. Snell, A. C.; Gradle, H. S., and Cordes, F. C.: Report of the Committee on Visual Standards for Operating Motor Vehicles, Tr. Sect. Ophth., A. M. A., 1938, p. 334.

3. Duke-Elder, W. S.: The Practice of Refraction, ed. 4, Philadelphia, The Blakiston Company, 1943, p. 103.

All refractions were done with homatropine cycloplegia. The visual acuities and corrections recorded in the tables are the best obtainable monocularly on one or more postcycloplegic examinations.

Adler [4] stated that visual testing involves the psychological factors comprising the powers of attention and concentration and the physiological factors of precise extrinsic ocular muscle control, so that the retinal image of the test objects falls exactly on the fovea. Accordingly, in this study, individual letters and lines of test type were used. The few illiterates or mental defectives included were tested with appropriate charts for illiterates or children. All subjects with nystagmus or paralysis of the extrinsic ocular muscles were excluded.

Bahn [5] stated that a psychoneurotic factor capable of affecting symptomatic recovery occurs in 75 per cent of patients with ophthalmic diseases. He placed amblyopias or poor vision without sufficient objective explanation high on the list of frequent psychoneurotic manifestations. In military ophthalmology, the importance of hysteria in producing amblyopia has been further emphasized by Mahoney and Linhart [6] and Halpern.[7] Since, as Ossipov [8] pointed out, malingering belongs properly to the domain of psychiatry, every malingerer being an unstable person, a psychopath, and since characteristic field changes are described [9] for the psychoneuroses, my colleagues and I deemed it advisable to include malingering tests for visual acuity and examinations of peripheral and central visual fields in our routine studies. As the final step in our evaluation of this phase of the problem, neuropsychiatric work-ups were obtained in as many cases as possible. Unfortunately, because of the frequent transfers of military personnel and the usually prolonged period of investigation entailed in a complete neuropsychiatric work-up, not all cases could be so analyzed.

Tests for visual malingering have been thoroughly explained by Agatson [10] and Bruce.[11] Both for unilateral and for bilateral amblyopia I have found the visual angle test the most appropriate and the easiest to carry out; the visual acuity was simply determined at 20 feet (6 M.) and compared with that obtained on a different test chart at 10 feet (3 M.). In cases of bilateral amblyopia the reading material of the patient, obtained without his knowledge from the ward or elsewhere, was compared with the Jaeger test type read by him during a formal examination. In cases of unilateral amblyopia a host of tests are available; the prism tests

4. Adler, F. H.: Clinical Physiology of the Eye, New York, The Macmillan Company, 1933, p. 123.

5. Bahn, C. A.: The Psychoneurotic Factor in Ophthalmic Practice, Am. J. Ophth. **26**:369, 1943.

6. Mahoney, V. P., and Linhart, W. O.: Amblyopia in Hysteria: Report of 13 Cases, War Med. **3**:503, 1943.

7. Halpern, H. J.: Hysterical Amblyopia: Report of Cases, Bull. U. S. Army M. Dept. (no. 72), 1944, p. 84.

8. Ossipov, V. P.: Malingering: The Simulation of Psychosis, Bull. Menninger Clin. **8**:39, 1944.

9. Peter, L. C.: Principles and Practice of Perimetry, Philadelphia, Lea & Febiger, 1931, pp. 265-274. Traquair, H. M.: An Introduction to Clinical Perimetry, ed. 4, London, Henry Kimpton, 1943, pp. 274-280.

10. Agatson, H.: Ocular Malingering, Arch. Ophth. **31**:223 (March) 1944.

11. Bruce, G. M.: Simple Methods for Detection of Ocular Malingering, U. S. Nav. M. Bull. **41**:755, 1943.

described by the aforementioned authors and by Irvine,[12] the Javal-Cuignet bar test and the test in which the good eye is fogged with a +3.00 or a +4.00 D. sphere or with a red lens and red test type used were all employed. A particularly satisfactory test is the one recommended by Lytton,[13] in which a +1.00 D. cylinder is placed in the rear, immobile groove of the trial frame at axis 90 and a —1.00 D. cylinder at axis 45 in the revolving compartment in front. The examinee is asked to rotate the latter cylinder until clearest vision is obtained. A malingerer is likely to end with the axes of the cylinders crossed, rather than coinciding.

Much has been written on the changes in visual fields accompanying amblyopia. Both the Wilkinsons [14] and Worth [15] stated that the peripheral fields are normal in amblyopia. Evans [16] found a central scotoma of 2 degrees. Sugar [17] stated that Uhthoff found a scotoma in 55 per cent of his cases and Heine in 90 per cent. Feldman and Taylor [18] found an incidence of field changes in amblyopia of 20 per cent, which, they averred, is hardly high enough to permit the establishment of a perimetric anomaly as pathognomonic of amblyopia. The changes which occur in hysteria and other psychoneuroses—concentric constrictions, tubular fields, reversal and interlacing of color fields, some form of ring scotoma and field changes on suggestion—are all well known and ably described in such standard texts on perimetry as those of Peter and Traquair. Our routine tests aimed at careful investigation of peripheral and central fields, the former being taken on a Ferree-Rand perimeter at 330 mm. with ½ and 1 degree white and 1 degree red and blue objects, the latter on a tangent screen of the Bjerrum type at 750 and 1,500 mm. with 1, 3, 6, 13 and 26 mm. white and 6 mm. red and blue objects.

RESULTS AND COMMENT

Of the 47 cases studied, bilateral unexplained amblyopia was present in 32, or 68 per cent (table 1), and unilateral unexplained amblyopia, in 15, or 32 per cent (table 2). This ratio is considerably at variance with that found by Theodore, Johnson, Miles and Bonser.[19] Of their 2,509 cases of unexplained amblyopia, the condition was bilateral in 0.55 per cent; in the rest it was unilateral. No ready explanation is at hand to account for this variance.

Refractive Errors.—Perusal of table 1 does not reveal predominance of any one type of refractive error in the cases of bilateral amblyopia. For six patients the refractive error exceeded 5 D., but in none was it high enough to be incompatible

12. Irvine, S. R.: A Simple Test for Binocular Fixation and Ocular Dominance, Air Surgeon's Bull. (no. 6) **1**:6, 1944.

13. Lytton, H.: Neutralizing Cylinder Glasses as Test for Malingering, Brit. J. Ophth. **26**:512, 1942.

14. Wilkinson, O., and Wilkinson, R. W.: Strabismus: Its Etiology and Treatment, ed. 2, Boston, Meador Publishing Company, 1943, p. 56.

15. Worth, C.: Squint: Its Causes, Pathology and Treatment, ed. 5, Philadelphia, The Blakiston Company, 1921, pp. 62-77.

16. Evans, J. N.: A Scotoma Associated with Strabismus, Am. J. Ophth. **12**:194, 1929.

17. Sugar, H. S.: Supression Amblyopia, Am. J. Ophth. **27**:469, 1944.

18. Feldman, J. B., and Taylor, A. F.: Obstacle to Squint Training—Amblyopia, Arch. Ophth. **27**:851 (May) 1942.

19. Theodore, F. H.; Johnson, R. M.; Miles, N. E., and Bonser, W. H.: Causes of Impaired Vision in Recently Inducted Soldiers, Arch. Ophth. **31**:399 (May) 1944.

TABLE 1.—*Bilateral Unexplained Amblyopia*

Patient	OD		OS		Malingering Tests	Visual Fields *	Psychiatric Examination
	Vision	Correction	Vision	Correction			
E. E.	20/70	+0.50	20/70	+0.50	+	Severe constrict., tubular	Mental deficiency
R. K.	20/100	−4.50+6.00ax110	20/100	−3.50+7.00ax75	−	Interlacing B & R.; 3° central scotoma	Not done
C. B.	20/100	+1.50+0.25ax180	20/60	+1.50	−	OS; interlacing B & R	No psychiatric problem
J. B.	20/300	+0.25	20/400	+0.25	−	Slight concen. constrict.; interlacing B & R, OS	Long-standing moderate hysteria
L. T.	20/50	−0.25−0.50ax180	20/50	−0.25+0.50ax90	+	Constrict., tubular	Simple adult maladjustment
W. D.	20/200	−0.50	20/70	−0.50−0.25ax180	+	Constrict., tubular	Mental deficiency
A. M.	20/50	−1.50−2.00ax15	20/50	−1.50−2.25ax170	−	Normal	No psychiatric problem
V. T.	20/50	+0.75+0.50ax90	20/50	+1.00	+	Severe constrict., tubular	Schizophrenia
R. L.	20/100	−1.50	20/100	−1.50	+	Normal	Simple adult maladjustment
J. G.	20/200	−1.75−2.25ax20	20/200	−2.75−2.00ax155	+	Moderate constrict., tubular	Severe hysteria
R. T.	20/50	−5.25	20/50	−5.25	−	Normal	Not done
J. P.	20/50	−0.25−1.00ax10	20/50	−2.75ax170	−	Normal	Not done
J. S.	20/200	−0.25−2.75ax175	20/200	−1.00−1.00ax180	+	Severe constrict., tubular; interlacing B & R	Simple adult maladjustment
J. M.	20/70	+0.50+0.25ax110	20/70	+0.25+0.25ax65	+	Severe constrict., tubular	Not done
A. L.	20/200	+4.00+0.50ax20	20/50	+3.25+1.25ax165	−	Slight constrict., tubular; interlacing B & R, OD	Illiteracy; constitutional psychopathy; mental deficiency
F. C.	20/70	+7.50+1.25ax80	20/70	+7.25+2.00ax105	−	Slight concen. constrict.	Not done
V. L.	20/70	+0.25−2.75ax25	20/50	−0.25−1.75ax155	−	Interlacing B & R, OD	Not done
W. J.	20/70	+4.00+0.50ax90	20/70	+4.50+1.00ax90	−	Normal	Not done
G. O. H. M.	−0.25−2.25ax180		20/70	−0.75−1.75ax180	−	Constrict., tubular; interlacing B & R	Constitutional psychopathy
P. G.	20/50	−1.00ax165	20/50	−0.50ax65	−	Moderate constrict.; interlacing B & R, OD	Psychoneurosis; hypochondriasis, mild
T. K.	20/60	−3.25ax145	20/60	−2.25−3.00ax125	+	Moderate constrict.; interlacing B & R	Not done
H. H.	20/70	+5.50+0.25ax180	20/100	+6.00	−	Moderate constrict.	Mental deficiency
P. Z.	20/200	−0.50+4.50ax112	20/200	−0.50+3.50ax52	−	Slight constrict., tubular; annular scotoma; blind spots suggestible in all quadrants	Mental deficiency, moron grade; hysteria
M. F.	20/80	−0.50ax180	20/300	−0.50ax180	+	Scotoma for B.; blindspot unobtainable	Mental deficiency; conversion hysteria
L. D.	20/50	+0.50+0.25ax15	20/300	+0.50+0.25ax170	+	Very severe constrict., tubular	Borderline mental deficiency
I. A.	20/100	+6.00+1.00ax95	20/100	+6.50+1.00ax165	+	Constrict., tubular	Psychoneurosis, severe; depression
H. O.	20/50	+1.25+2.00ax85	20/50	+0.50+2.00ax67	+	Normal	Psychoneurosis, severe, mixed type, schizoid
W. W.	20/70	−0.75+2.75ax135	20/70	−0.75+1.75ax35	+	Interlacing B & R	Psychoneurosis, anxiety state; repressed homosexuality
M. C.	20/60	−1.00ax180	20/60	−0.75+1.00ax90	+	OS: normal; OD: annular scotoma, interlacing B & R and small central scotoma for B & R	Mental deficiency, moron; illiteracy
R. Y.	20/60	−2.00+4.75ax87	20/60	−1.00+4.50ax85	−	Normal	Not done
E. P.	20/100	+2.50+0.50ax90	10/400	+4.00+2.00ax90	+	Constrict., tubular	Constitutional psychopathy; inadequate personality
W. H.	12/200	+2.50+0.25ax90	10/300	+3.00	+	OD: moderate concent. constrict.; OS: constrict., tubular	Severe hysteria

* "B & R" means "fields for blue and red"; "concen." means "concentric," and "constrict." means "constricted" and "constriction."

with good corrected vision, as was found in many other soldiers and veterans with similar, or even higher, errors. The rest of the patients had low or moderate refractive errors.

Consideration of the cases of unilateral amblyopia in table 2, on the other hand, shows isohypermetropia in 12 of the 15 cases, with values averaging 3.24 D. for the amblyopic eye and 3.05 D. for the normal eye. This group approximates Sugar's [17] cases of unilateral amblyopia with high isohypermetropia and without squint. He claimed for this group that suppression takes place in the more ametropic eye in order that the patient may avoid diplopia resulting from the excessive convergence, in the effort to obtain clear binocular vision. The excessive convergence, in turn, is associated with the need of great accommodative effort in obtaining clear

TABLE 2.—*Unilateral Unexplained Amblyopia*

Patient	OD		OS		Malingering Tests	Visual Fields *	Psychiatric Examination
	Vision	Correction	Vision	Correction			
A. J.	20/70	+4.00+1.50ax125	20/40	+3.00+1.25ax65	—	Slight concen. constrict.	Psychoneurosis; hypochondriasis, mild
H. S.	20/100	+4.00+1.00ax90	20/30	+3.50+1.50ax90	—	Normal	Not done
E. M.	20/20	+3.25+0.50ax65	20/70	+3.25+0.50ax90	—	Slight concen. constrict., OS	Not done
B. G.	20/30	+3.75	20/200	+4.00	—	Interlacing B & R	Not done
R. F.	20/25	−2.75−1.50ax180	20/00	−2.25−1.50ax180	—	Moderate constrict., tubular; interlacing B & R	Psychoneurosis, mild; conversion hysteria
O. G.	20/50	+0.75+3.25ax120	20/40	+2.00+2.50ax120	—	Interlacing B & R, OS	Not done
W. B.	20/30	+0.75	20/50	+1.50+1.25ax105	—	Constrict., tubular, OS	Not done
R. H.	20/70	+3.50+0.50ax80	20/25	+3.50+0.25ax180	—	Normal	Not done
S. H.	20/70	−0.25−0.25ax155	20/20	−0.25ax180	—	Normal	Not done
S. R.	20/200	+0.50	20/15	Plano	—	Normal	Not done
A. L.	20/80	+1.00+0.75ax180	20/30	+1.00	—	Slight concen. constrict. and interlacing B & R, OD	Mental deficiency; mild hysteria
J. B.	20/30	+5.25+0.75ax100	20/300	+4.75+2.50ax90	—	Moderate concen. constrict., OS	Not done
H. D.	20/15	+3.50	20/70	+3.50	—	Normal	No psychiatric problem
J. M.	20/40	−2.25+4.75ax85	20/50	−1.25+4.50ax90	—	Normal	No psychiatric problem
J. L.	20/20	+3.50	C. F. at 6"	+3.75+0.25ax60	—	Severe concen. constrict., OS	Simple adult maladjustment

* "B & R" means "fields for blue and red"; "concen." and "constrict." mean "concentric" and "constriction."

vision and continues to be associated with accommodation even though amblyopia develops. Squint does not develop if the hypermetropia exceeds the ability of the accommodation to permit clear vision. The normal eye in each of Sugar's cases was correctible to 20/20, but this acuity was clearly obtainable in only three of ours. Perhaps, as well as diplopiaphobia, poor discriminatory power or some other psychological factor plays a role in the production of this type of suppression amblyopia, as Sugar called it.

Malingering Tests.—No instances of malingering were encountered in the cases of unilateral amblyopia, but in 17 instances (53 per cent) one or more positive tests for malingering were encountered in the cases of bilateral amblyopia. It is noteworthy that the cases of severest amblyopia are included in the same group. All but 2 of the malingerers had visual field changes, for the most part rather

pronounced, typical of functional nervous disease. Psychiatric consultation was obtained in 15 of the 17 cases; in all 15 cases there were psychiatric problems, ranging in severity from borderline mental deficiency to schizophrenia. The conclusion may be derived that a patient with unexplained bilateral amblyopia with a positive test for malingering is a psychiatric problem. Negative tests for malingering do not, however, necessarily exclude such a problem, as careful visual field and psychiatric examinations may reveal.

Visual Fields.—Changes in visual fields of one type or another were recorded in 34 cases (72 per cent). Of the cases of bilateral amblyopia, 78 per cent, and of the cases of unilateral amblyopia, 60 per cent presented changes. The commonest type of field change noted (26 of 34 instances) was concentric constriction, ranging from slight (peripheral limits of form field between 40 and 60 degrees) in 7 cases, through moderate (limits between 20 and 40 degrees) in 7 cases, to severe (limits below 20 degrees) in 13 cases. Interlacing of color fields occurred in 14 cases. No instance of complete reversal of the blue and red fields was noted. Tubular fields were demonstrated in 15 cases, in 13 of which psychiatrists found a psychiatric problem. This is further corroboration of the well known correlation between tubular fields and functional nervous disorders. Three cases of small central scotoma were found, one absolute and two relative. One patient with bilateral amblyopia with tubular fields, diagnosed as mentally defective and hysterical, presented an annular scotoma and, on suggestion, a blindspot similar to Mariotte's in all four quadrants. One other case of annular scotoma was found, also in a patient with bilateral amblyopia with mental deficiency.

SUMMARY AND CONCLUSIONS

Forty-seven consecutive cases of amblyopia not associated with the usual causes, such as strabismus and anisometropia, were studied. In 32 the amblyopia was bilateral, and in 15, unilateral.

1. Isohypermetropia was overwhelmingly common in the cases of unilateral amblyopia, but no significant type of refractive error was found in the cases of bilateral amblyopia.

2. No case of malingering was encountered among the patients with unilateral amblyopia, but more than half the patients with bilateral amblyopia gave positive tests for visual malingering.

3. A patient with unexplained bilateral amblyopia with a positive test for malingering will almost uniformly be found to be a psychiatric problem, but the absence of malingering does not necessarily exclude such a problem.

4. In about three fourths of all cases, visual field changes, most commonly concentric constrictions, tubular fields and interlacing color fields, were presented. Only three cases of central scotoma were encountered. The correlation between tubular fields and functional nervous disorders is particularly high.

HYSTERICAL AMBLYOPIA IN CHILDREN AND YOUNG ADULTS

ELTON R. YASUNA, M.D.
WORCESTER, MASS.

IN THE practice of ophthalmology, hysterical amblyopia is considered a rare encounter. Reports in the literature give isolated instances, such as the study by Redslob and Brini [1] of a 14 year old girl who had onset of hysterical blindness after seeing the movie "Symphonie pastorale," which deals with a young blind girl. The patient's condition improved when she was threatened with ocular surgery.

In military service, ophthalmologists have reported series of cases of ocular hysteria, but they stated that such cases were seldom seen in civilian life. Halpern [2] described the cases of 15 soldiers in whom acute amblyopia developed while they were awaiting overseas duty at a preembarkation camp. The degree of amblyopia was about 20/100 or 20/200, while the field changes were tubular and usually less than 20 degrees.

Another series, of 13 servicemen, was described by Mahoney and Linhart,[3] in whom the condition existed in chronic form. The signs had been present for weeks or months, and the diagnosis was substantiated by the fields and psychiatric changes. These authors called attention to the fact that many of these patients had pre-existing visual difficulties, such as a refractive error or mild impairment of vision, and that emotional immaturity and a tendency toward substandard intellect were frequent.

Isolated reports of civilian cases can be found in the literature, but for the most part they have been regarded as ophthalmologic curiosities. No large series of cases of hysterical amblyopia have been described in civilian life.

The present report is concerned with the study of 19 cases of ocular hysteria, all with amblyopia, seen in the four year period from 1946 to 1949 inclusive. For the most part, each patient presented a diagnostic problem from the start, with poor vision in one or both eyes, for which the usual refraction and ophthalmoscopic examinations revealed no cause. The examiner believed that the case was functional rather than organic, and the possibility of malingering was entertained. It was only after a complete, and often time-consuming, work-up that the diagnosis of hysterical amblyopia was established.

From the Ophthalmological Services of the Worcester City Hospital and the Boston City Hospital.

1. Redslob, E., and Brini, A.: Les méfaits de la "Symphonie pastorale," Ann. d'ocul. **180**: 104-106 (Feb.) 1947.

2. Halpern, H. J.: Hysterical Amblyopia: Report of Cases, Bull. U. S. Army M. Dept. (no. 72) (Jan.) 1944, pp. 84-87.

3. Mahoney, V. P., and Linhart, W. O.: Amblyopia in Hysteria: Report of 13 Cases, War Med. **3**:503-507 (May) 1943.

REPORT OF CASES

Incidence.—As previously mentioned, a total of 19 patients were seen in four years. These patients were examined either in the office or in the ophthalmologic clinics of the Worcester City Hospital and the Boston City Hospital. It is not possible to state the true incidence of this condition, since some of the patients were referred to the office or presented themselves at the clinic because of my known interest in this problem. Although ocular hysteria is certainly rare, it is not so unusual as to be regarded as a medical curiosity, and should be considered seriously in cases of amblyopia of unknown cause.

Ocular Findings in Nineteen Patients with Hysterical Amblyopia

Case No.	Age	Sex	Maximum Corrected Vision: First Examination OD	First Examination OS	After Suggestion OD	After Suggestion OS	Visual Fields, Degrees	Other Ocular Findings
1	12	M	20/200	20/200	20/100 (−1.00 sph.)	20/200	35	Slightly irregular pupils; poor corneal reflex
2	19	F	20/70	20/50	Same	Same	4	Slow pupillary reaction
3	23	F	20/200	20/40	Same (pinhole disk)	Same (pinhole disk)	25	Pupils slightly dilated
4	10	F	20/100	20/70+1	20/20-2 (+0.75 sph.)	20/20-1 (+0.50 sph.)	20	None
5	16	M	20/100	20/200	20/20 (+0.50 cyl.)	20/20 (+0.50 cyl.)	20	None
6	14	M	20/70	20/70+2	20/20 (plano-convex)	20/20 (plano-convex)	20	None
7	13	F	20/100	20/100	20/20 (+0.50 sph.)	20/20 (+0.50 sph.)	20	None
8	29	F	Motion; poor light projection	20/30	Same	Same	OD:1 OS:15	None
9	9	F	20/70	No light perception	20/30 (pinhole disk)	20/30 (pinhole disk)	OD: Full OS: No fixation	None
10	24	M	20/20	20/200	.....	20/50 (+3.50 sph.)	OD: 25 OS: 35	Prolonged twitch; closed left upper lid; poor corneal reflex
11	10	F	20/100	20/100	Same (+0.50 sph.)	Same (+0.50 sph.)	25	None
12	35	F	20/100	20/70	Same	Same	15	None
13	50	M	20/40-2	No light perception	20/40	20/40 (pinhole disk)	OD: 15 OS: 2	None
14	13	F	20/30	20/30	Same	Same	30	None
15	28	M	20/20	Fingers at 1 ft.	Same	Same	25	Faint corneal scar (OS), due to injury in service
16	34	F	20/20	20/30—	Same	Same	15	Traumatic iris (OS); diplopia due to mild esotropia
17	13	F	20/100	20/100	20/20 (plano-convex)	20/20 (plano-convex)	15	None
18	9	F	20/600	20/600	20/200	20/200	20	Compound myopic astigmatism
19	40	F	20/70	20/60	Same	Same	15	None

Age.—The condition was seen mainly in children and young adults. The youngest patient was 9 years of age, while the oldest was 50. All but four patients were under 30, and over 40 per cent were children below the age of 13.

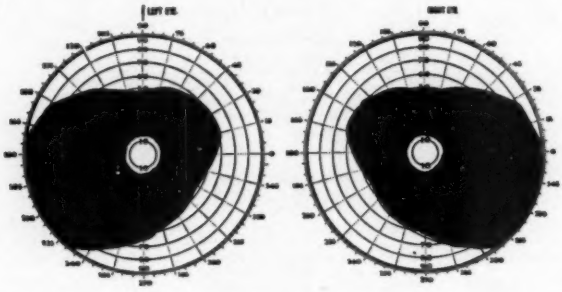
Sex.—This series comprised 13 females and six males. The males were equally divided into adults and children. On further analysis, it was found that of the three adult males, two were veterans of military service who were being evaluated for service liability and one was an employee in a situation involving compensation. The other three males were older children, aged 12, 14 and 16. The 13 female patients could also be divided roughly into two equal groups, six adults and seven children. In this study the condition was seen much more frequently in girls and young women, in the proportion of about two females to each male.

Vision.—Ocular hysteria is usually manifested by amblyopia. The amblyopia is generally chronic and gradual in onset, although acute episodes are reported.

All the patients had as their chief complaint poor vision in one or both eyes (table). All but four patients had bilateral involvement. There was considerable variation in the severity of the visual impairment. Three patients had so little vision that they either were unable to perceive light or had difficulty with light projection. The majority presented themselves with vision between 20/70 and 20/200. In two instances the vision was as good as 20/30—, but they were investigated because of the complaint of impaired vision. In all cases the vision was unimproved by the initial refraction, and the examiner was left with no explanation of the amblyopia.

It was only after further investigation, including careful field studies, had established the diagnosis of hysterical amblyopia that the admission of visual improvement could be elicited. This was done by the use of suggestion, in which the patient was sympathetically encouraged to read the chart. The patient was given frequent rests and then led on to read another letter or another line by the examiner's placing a different lens in the trial frame. This "different lens" was either plano convex or a minimal sphere. Interestingly, the patient frequently read down to the 20/20 line, when originally he could not be moved beyond his amblyopic position, which was usually between 20/70 and 20/200.

The reading was slow and deliberate, requiring as much effort on the part of the patient to see the largest letter on the chart as to read the 20/20 line (or whatever line he was able to see).



Visual fields in a case of hysterical amblyopia, showing constricted, circular [illegible] with sharp borders. The field sizes were identical at 0.5, 1 and 3 M.

This was characteristic of most cases reported here, as well as of a group of military cases previously described.[4] It required considerable time and patience on the part of the examiner because of the frequent long pauses by the patient in his recitation of the letters. Of this series, roughly half showed improvement in their vision after suggestion, while the remainder persisted in their amblyopia.

Visual Fields.—All visual fields were studied on the tangent screen rather than on the perimeter. Greater flexibility was possible with the screen in the use of test objects, placing of the patient, etc. The initial field was taken at the standard distance of 1 meter, with an appropriate test object for the amount of vision present.

A constricted circular field ranging from 1 to 35 degrees was constantly found (chart). Most of the fields were between 15 and 25 degrees, but three persons had less than 5 degree fields. Test objects varied from a 2 mm. target to a sheet of white paper 9 by 12 inches (22.8 to 30.5 cm.) in size. Regardless of the size of the test object, it was found that the shape and size of the field remained constant. The patient was then moved back 3 to 4 meters from the screen, and the fields were again plotted. In all cases no significant change was found in the size of the field. In a few instances the fields became slightly larger, but never in proportion to what would be expected. Surprisingly, some of the fields actually shrank when the patient was

4. Yasuna, E. R.: Hysterical Amblyopia: Its Differentiation from Malingering, Am. J. Ophth. **29**:570-578 (May) 1946.

placed farther back from the screen. The size of the test object was usually increased to compensate for the difference in distance, so that visual acuity would not influence the size of the field.

The fields had certain characteristics worthy of mention. They could be taken many times and showed constancy in their size. There was no tendency toward concentric diminution of the field, or the so-called spiral field, as encountered in cases of neurasthenia. In these cases of hysterical amblyopia the fields were of the same size regardless of the distance of the patient from the screen and were independent of the size of the test object used. This field is known as the "tubular field."

Another constant characteristic of the visual field was the presence of steep, sharp borders (chart). In organic disease of the optic pathways, the field margins show gradations, varying with the size of the test object.

The normal temporal enlargement of the field was lost, and an almost perfect circle was plotted, instead of the usual irregular contour. The fields were so regularly round as to appear almost to have been drawn with a compass with the center at the fixation point.

Eames [5] plotted peripheral field tracings on 193 school children who had been referred for reading difficulty and found constricted tubular fields in 9 per cent. Further evaluation of those with tubular fields revealed that 83 per cent were failing in their school subjects and 44 per cent exhibited varying degrees of amblyopia. A diagnosis of hysteria was suspected for 77 per cent of the children with tubular fields. Eames stated the belief that the combined presence of tubular fields and amblyopia was a more reliable indication of possible hysteria than either one taken alone.

Response to Tests of Malingering.—In some of the patients a number of responses were elicited which were highly suggestive of malingering. For instance, several patients with vision of 20/200 unimproved by refraction were able to read Jaeger type 1. This finding was obviously inconsistent. Also, such tests as placing of a pinhole disk before the amblyopic eye resulted at times in improved vision, once again creating suspicion in the mind of the examiner. The subjects in this report had no difficulty in getting about. They walked from room to room with ease, never bumping into objects. Malingerers, on the other hand, act hopelessly blind, and, as Eggers [6] has succinctly remarked, "they invariably overplay their part.

During the examination the hysterical subjects were cooperative and patient, allowing repeated tests to be performed. Malingerers are often antagonistic to the examiner and show quick annoyance if tests are repeated or if the examination becomes too lengthy. While malingerers usually limit their deceit to one eye, most of the present series had bilateral involvement. Excellent and detailed discussions on malingering tests are contained in reports by Unsworth [7] and Carpenter.[8]

Other Ocular Findings.—Pupillary changes were seen occasionally. In some the pupils were irregular, dilated or slow in reaction. Other ocular findings have also been described,[9] such as corneal anesthesia, diplopia, blepharospasm and ptosis. One patient had a prolonged slow twitching of the left upper lid, which frequently developed into a blepharospasm. The corneal reflex was diminished in two cases. Diplopia was present in a woman with 15 degrees of esotropia, which had existed for many years.

Psychiatric Background.—These patients were found to have poor emotional stability and frequently were of less than average intelligence. Many of the children in this group were

5. Eames, T. H.: A Study of Tubular and Spiral Central Fields in Hysteria, Am. J. Ophth. **30**:610-611 (May) 1947.

6. Eggers, H.: Estimation of Uncorrected Visual Acuity in Malingerers, Arch. Ophth. **33**:23-27 (Jan.) 1945.

7. Unsworth, A. C.: A Discussion of Ocular Malingering in the Armed Services, Am. J. Ophth. **28**:148-159 (Feb.) 1945.

8. Early Recognition and Treatment of Neuropsychiatric Conditions in the Combat Zone, Surgeon General, United States Army, in Medicine and the War, J. A. M. A. **123**:705-706 (Nov. 13) 1943.

9. Head, H., and others: Studies in Neurology, New York, Oxford University Press, 1920.

doing poorly in school. There was a frequent history of repeated grades, with poor adjustment either to teachers or to classmates. Some of the children were living in foster homes or in situations where there had been a divorce or a separation of the parents. One of the mothers stated that she did not feel affectionate toward her child but was sure the child did not realize this. Two children were habitual bedwetters. One case of amblyopia was that of a mother who had borne several children during her first few years of marriage and was expecting another child. Subsequent questioning showed that she resented her pregnancies and did not wish to have more children.

In all instances psychiatric consultation was advised. The clinic patients were sent to the psychiatrist, and some were later referred to the child guidance clinics. The private patients were also referred, but some failed to reach psychiatric care for various reasons. The end results of psychiatric treatment in these cases were not always satisfactory. Occasionally the amblyopia subsided, only to have other manifestations of hysteria develop. In cases in which close contact was maintained with the psychiatrist, it was found that the amblyopia was only one of the manifestations of hysteria and that other evidences of the same disease were present. The hysteria, therefore, was not monosymptomatic.

COMMENT

In this series of cases the disease was more frequent in young females. The few adult males were either injured ex-servicemen or workmen. Unexplained amaurosis in a person, especially a female, between the ages of 9 and 35 warrants the most careful investigation for hysteria. Little comment is required on the visual findings except to remark that poor vision is the presenting complaint. Characteristically, the patient appears to try hard in his attempt to read but is slow and deliberate.

The peripheral field findings are most important in the establishment of a diagnosis of hysterical amblyopia. There is variation in the size of the field but practically no difference in its characteristics. Once a small circular field has been determined, and it is found that the identical field is present with the patient placed at a considerably greater distance from the screen, the diagnosis of hysteria can be made. No other functional condition simulates this finding of a tubular field.

Traquair [10] stated that "the difficulty [tubular fields] is present when the examination begins and is usually constant while the test is proceeding, unless altered by suggestion." He also wrote:

> . . . in neurasthenia, anxiety neurosis or traumatic neurosis, the fields are characterized by instability. The field usually appears somewhat constricted to begin with, and during the examination it soon shrinks. . . . Continuing the process a contracting or moderate spiral is produced on the chart terminating in a more or less small central field.

In hysteria the field is found to be small and circular. On repeated plottings it is amazing to note the constancy with which the patient produces the exact replica of the original field. This also holds when the patient is placed 3 or 4 meters from the screen.

The borders are always steep, and this feature helps in the differentiation from an expanding lesion or an inflammatory process. The size of the fields can be duplicated within a degree, even when variations in test objects from 5 mm. to large sheets of white paper are used.

---

10. Traquair, H. M.: An Introduction to Clinical Perimetry, ed. 4, St. Louis, C. V. Mosby Company, 1943.

It cannot be emphasized too strongly that the responses to tests usually employed for the detection of malingering must be evaluated with extreme caution. Some of these patients could read Jaeger type 1, although distant vision was only 20/200. Improvement with the use of the pinhole disk was not infrequent. Wechsler [11] stated:

> . . . in unilateral hysteric blindness, one may be able to induce diplopia with prisms. A good test is to blind the seeing eye with a powerful lens, cover the affected one with a plain glass, then ask the patient to read. In actual blindness, this is impossible.

Wechsler was describing so-called malingering tests and pointing out that the responses in hysterical amaurosis may be positive for malingering. In no manner would these isolated responses be accepted as proof of malingering until further corroboration is obtained and the possibility of hysteria eliminated.

Surprisingly, the terms hysteria and malingering are sometimes interchanged and considered to be "almost the same." Moersch [12] has correctly emphasized that these terms are not synonymous and should not be used interchangeably.

The malingerer is conscious of his deceit and is actually refusing to read something which is visible to him. The hysterical subject actually cannot see any more than he is reading at the moment. He is sick, with a definite illness, and only deceives himself, without malice or design, unlike the malingerer, who is aware of the falseness of his responses. Unfortunately, both are poorly constituted emotionally.

Spaeth,[13] in his review of hysterical amblyopia, stated that "the hysterical makeup from the standpoint of personality defects was manifested by a poor synthesis of the personality." The phenomenon of hysterical amblyopia is fascinating when one realizes that the patient has subconsciously refused to see and has relegated his visual sensations to the subconscious, as described by Janet.[14] The development of hysteria is the response of the patient to a seemingly impossible situation. The old idea of "fight or flight" is evidenced here by the flight of the patient from reality into sickness. He refuses to see, and thus hides behind a protective covering of blindness, which excuses him from continuing in the competition of life.

Although the development of amblyopia in hysterical persons may seem infantile and ineffectual, it is the most efficient method the patient has of responding and adjusting to a situation. Freud [15] showed that repression is both the fundamental factor in and the basis of hysterical manifestations. Fortunately, true vision continues to exist in the subconscious. It does not deteriorate permanently, and, with proper psychiatric care and guidance, a liberation of vision from the jail of the subconscious can be brought about.

---

11. Wechsler, I. S.: Textbook of Clinical Neurology, ed. 5, Philadelphia, W. B. Saunders Company, 1943.

12. Moersch, F. B.: Malingering, with Reference to Its Neuropsychiatric Aspects in Civil and in Military Practice, M. Clin. North America **28**:928-944 (July) 1944.

13. Spaeth, E. B.: Differentiation of Ocular Manifestations of Hysteria and Ocular Malingering, Arch. Ophth. **4**:911-918 (Dec.) 1930.

14. Janet, P. M. F.: The Major Symptoms of Hysteria, ed. 2, New York, The Macmillan Company, 1920.

15. Freud, S.: Selected Papers on Hysteria, translated by A. A. Brill, Nervous and Mental Disease, monograph 4, New York, Nervous and Mental Disease Publishing Company, 1912.

CONCLUSIONS

Nineteen cases of hysterical amblyopia in civilians were studied.

The amblyopia was bilateral in almost 80 per cent of cases.

The condition was twice as frequent in females as in males, and most patients were between the ages of 9 and 35.

Characteristic fields were constricted, circular and tubular. Steep borders were also constant.

Tests for malingering frequently gave positive results. Other manifestations of hysteria were present.

Psychiatric aid should be sought whenever possible.

44 Pearl Street.

Clinical Notes

AN IMPROVED LIGHT SOURCE FOR THE ZEISS-NORDENSON FUNDUS CAMERA

GLEN FLOYD, M.D.
WINFIELD, KAN.
AND
R. B. STITH
SAN DIEGO, CALIF.

In using the Zeiss-Nordenson fundus camera one frequently encounters difficulties in connection with the carbon arc light source. The carbons must be frequently realined as they are in use, with the subsequent need of refocusing. There are momentary changes in the luminosity due to irregularities in the carbons; if

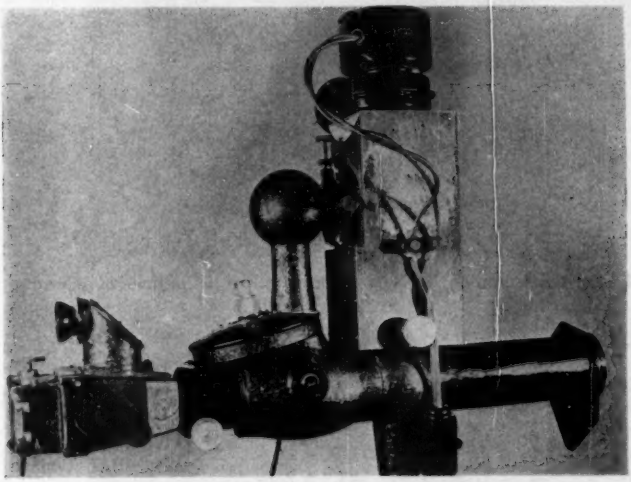


Fig. 1.—Photograph of Zeiss-Nordenson camera with new lamp in place.

this occurs at the moment the film is exposed, overexposure or underexposure results. Not the least of its disadvantages is the need of frequent change to new carbons. If this occurs part way through the course of photographing one patient, one must stop and wait until the mechanism cools sufficiently to permit changing the carbons. The new fundus camera recently constructed by the Bausch & Lomb Optical Company has numerous refinements making for greater ease of operation, but the light source is also from a carbon arc. The Zeiss Company has produced an incandescent light source for their camera, utilizing a U-shaped filament so placed that the reflex produced falls outside the field being photographed. Only a few of these light sources are available, and, unfortunately, the light produced is frequently inadequate for good color work.

It was believed that one of the high intensity lamps, ordinarily used in motion picture projectors, might provide an adequate light source for the fundus camera. For this purpose a 1,000 watt, prefocused motion picture projection bulb was used.

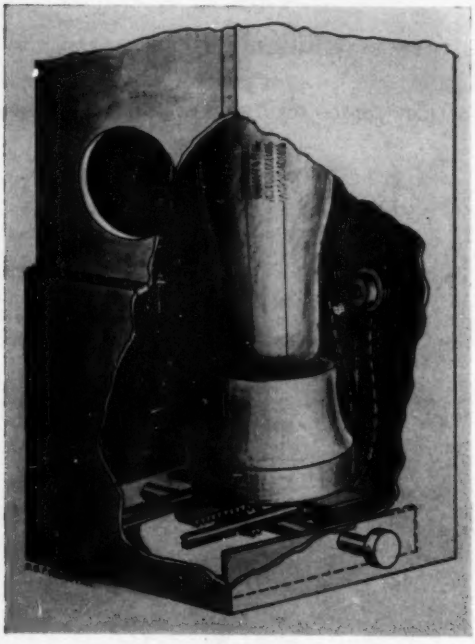


Fig. 2.—Cut-away drawing of lamp house to illustrate method of mounting lamp.

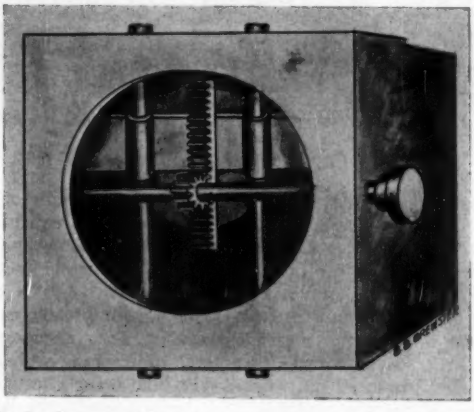


Fig. 3.—Bottom of lamp house, showing detail or rack gear.

A new lamp house with a cooling fan was constructed (fig. 1), in which was placed a light socket mounted on a simple rack to permit adjustment of the distance from the lamp to the first condensing lens (figs. 2 and 3). The circular opening in the base permits entrance of air for cooling. Vertical and horizontal adjustments are made on the universal joint between the camera and the lamp house.

In use, it was found necessary to remove the color-correcting filter, which is present just behind the first condensing lens. Further improvement was gained by coating the condensing lens and the front lens of the camera with magnesium trifluoride in the usual manner now in common use.

The camera, with this incandescent light source, has now been in use at the Illinois Eye and Ear Infirmary for several months. The results obtained in several hundred fundus photographs have been equal and, in some respects, superior to those in which the carbon arc was used. Color reproduction is adequate, with type A kodachrome® film, and consistent color duplication is better than was obtained previously. Both the ease of operation and the percentage of good pictures obtained have been increased. Good results have been achieved on the first attempt by members of the resident staff. With the carbon arc light source considerable practice is necessary, and even then the operator is frequently disappointed with the results.

Snyder-Jones Clinic, Winfield, Kan. (Dr. Floyd).

Ophthalmological Reviews

PERIPHERAL VISUAL ACUITY

FRANK N. LOW, Ph.D.
NEW ORLEANS

PERIPHERAL visual acuity has been the subject of speculation since ancient times and in the last 100 years has been measured quantitatively by numerous investigators. The purpose of this paper is to survey the present status of knowledge in this field. A short historical sketch is followed by the presentation of quantitative data. Consideration is given to the factors known to affect various measurements and to the probable significance of each. Peripheral visual functions, such as color vision, motion perception, light and dark adaptation and sensory studies, are omitted except when they have definite bearing on acuity problems. The measurements and methods associated with the study of central acuity are used for comparison.

HISTORICAL REVIEW

The superiority of central visual acuity over peripheral acuity led both Euclid (Magnus [1]) and Galen (Morton [2]) to compare vision to a cone, the axis of which was the line of central vision. The first notable experimental work occurred in 1668, when Mariotte [3] discovered the blindspot. Nearly a century later Porterfield,[4] in the most extensive treatise on the eye to appear up to that time, made only passing mention of peripheral acuity. He recognized progressive decline from axis to periphery, attributing it to imperfection of the optical image and insensitivity of the peripheral retina. The experimental approach was revived by Young,[5] who reported the peripheral extent of the visual

From the Department of Anatomy, The Johns Hopkins University, Baltimore.

This paper was prepared under a contract between the Office of Naval Research and The Johns Hopkins University (Contract N6onr-243, Task Order III, The Johns Hopkins University, Project NR143-262).

1. Magnus, H.: Die Kenntnis der Sehstörungen bei den Griechen und Romern, Arch. f. Ophth. **23**:24, 1877.

2. Morton, H. M.: Historic Memorabilia Regarding the Visual Field and Perimetry, Am. J. Ophth. **13**:888, 1930.

3. Mariotte, E.: Oeuvres, 1668, p. 496.

4. Porterfield, W.: A Treatise on the Eye: The Manner and Phenomena of Vision, Edinburgh, Hamilton & J. Balfour, 1759, vol. 2, p. 221.

5. Young, T.: On the Mechanism of the Eye, Phil. Tr. **1**:23, 1801.

fields in terms of angular deviation from the axis. Troxler,[6] and later Brewster,[7] observed subjective intermittency of constant peripheral stimuli. Purkinje[8] constructed special apparatus for the study of peripheral acuity, a flat card with movable pins, but did not report his results quantitatively.

The first quantitative measurement was reported by Hück,[9] whose work was soon followed by that of Volkmann,[10] Weber[11] and Aubert and Foerster.[12] Many other investigations followed, among which the careful and precise work of Wertheim[13] is now in general acceptance. Progress in the field is illustrated by the reviews of Aubert,[14] Snellen and Landolt,[15] Groenouw,[16] Ruediger[17] and Köllner,[18] the last of which is the most complete and critically the finest.

QUANTITATIVE MEASUREMENTS OF VISUAL ACUITY

Lythgoe has said that a satisfactory definition of visual acuity is not easy to give. Measurements are usually obtained by setting some task involving discrimination of detail, the detail being gradually reduced until the task can no longer be performed. From the use of such technic, various kinds of central acuity are now recognized,

---

6. Troxler, I. P. V.: Über das Verschwinden gegebenen Gegenstände innerhalb unseres Gesichtskreises, Ophth. Biblioth., 1804, vol. 7.

7. Brewster: Ann. Philos. **11**:151, 1818.

8. Purkinje, J. E.: Neue Beitrag zur Kenntnis des Sehens, in Physiologie der Sinne, Berlin, 1825, vol. 2.

9. Hück, A.: Vom der Gränzen des Sehvermögens, Arch. f. Anat., Physiol. u. wissensch. Med., 1840, p. 82.

10. Volkmann, A. W., in Wagner, R.: Handwörterbuch der Physiologie, Braunschweig, F. Vieweg u. Sohn, 1846, vol. 3, p. 525.

11. Weber, E. H., in Wagner, R.: Handwörterbuch der Physiologie, Braunschweig, F. Vieweg u. Sohn, 1846, vol. 3, p. 528.

12. Aubert, H., and Foerster: Beiträge zur Kenntnis des indirekten Sehens, Arch. f. Ophth. **3**:1, 1857.

13. Wertheim, T. H.: Über die indirekte Sehschärfe, Ztschr. f. Psychol. u. Physiol. der Sinnesorg. **7**:172, 1894.

14. Aubert, H.: Physiologie der Netzhaut, Breslau, E. Morgenstern, 1865.

15. Snellen, H., and Landolt, E.: Perioptometry, in von Graefe, A., and Saemisch, E. T.: Handbuch der gesamten Augenheilkunde, Leipzig, W. Engelmann, 1874, vol. 3, p. 52.

16. Groenouw, A.: Über die Sehschärfe der Netzhautperipherie und eine neue Untersuchungsmethode derselben, Arch. f. Augenh. **26**:85, 1892-1893.

17. Ruediger, W. C.: The Field of Distinct Vision, with Special Reference to Individual Differences and Their Correlations, Arch. Psychol. **5**:1, 1907.

18. Köllner, H.: Die Untersuchungen der Sehschärfe im indirekten Sehen, in von Graefe, A., and Saemisch, E. T.: Handbuch der gesamten Augenheilkunde, ed. 3, Leipzig, W. Engelmann, 1925, vol. 3, pp. 524-552.

depending on the test object used (Hartridge,[19] Roelofs and de Haan,[20] Lythgoe [21]). Among the better known test objects are (1) the minimum distinguishable, or visible, point (*physiologische Punkt*), for which a circle or square on contrasting background must be seen; (2) the minimum separable for points (*Empfindungskreis*), for which two points on contrasting background must be seen separately; (3) the minimum separable for lines, for which gratings must be seen as separate parallel lines; (4) simple form, for which letter-like forms, such as Landolt circles or Snellen prongs, must be positionally identified, and (5) minimum legible, for which letters must be read. Acuity defined by items 4 and 5 is frequently referred to as the "form sense." The term "form perception" loosely designates such categories but may also include measurements obtained with simple geometric or even more complex forms. So many test objects have been used to measure both central and peripheral acuity that more specific classification is impractical. Mention must be made, however, of the measurement of what is sometimes called vernier acuity (Duke-Elder [22]), which is the minimum perceptible displacement along an otherwise straight edge. The threshold for this measurement is recognized to be lower than that of the minimum visible point for centrally fixated areas of the retina. The kinds of central acuity indicated above follow in decreasing strength, in the order listed.

Investigators of peripheral acuity have all chosen their own technics. These have been so diverse that none can be considered the accepted method. Distance from the eye, angular deviation from the axis, test object size and test object form have all been varied at discretion. Nevertheless, it is possible to calculate a common expression of acuity whenever an adequate description of these conditions has been made available. For this purpose, the angle subtended at the eye by the test object or its discriminative portion is convenient. This method also has the advantage of ready comparison with expressions of central acuity now in general acceptance. In central vision an eye which can read test type the discriminative portions of which (i. e., the width of the component lines thereof) subtend an arc of 1 minute (1′), is gen-

19. Hartridge, H.: The Visual Acuity and the Resolving Power of the Eye, J. Physiol. **57**:52, 1922.

20. Roelofs, C. O., and de Haan, L. B.: Über den Einfluss von Beleuchtung und Kontrast auf die Sehschärfe, Arch. f. Ophth. **107**:151, 1921.

21. Lythgoe, R. J.: Illumination and Visual Capacities, Medical Research Council, Special Report Series, no. 104, London, His Majesty's Stationery Office, 1926.

22. Duke-Elder, W. S.: Text-Book of Ophthalmology, vol. 1, St. Louis, C. V. Mosby Company, 1932.

erally understood to have normal acuity. Snellen type, introduced in 1862 (Pergens [23]), is constructed of letters five times the width of the lines composing them, so that the normal eye can read letters subtending 5′ of an arc. This 5:1 formula has customarily been used in making letter and letter-like test objects for visual studies. Many investigators of peripheral acuity have used such test objects, and, wherever encountered, the width of the line composing them has been used to calculate the angle subtended. Data obtained in the measurement of the minimum distinguishable point have been calculated by using the diameter of the circle or square used. In cases involving the minimum separable for points and lines, the distance between the points or lines has been used. This treatment is the closest approach to numerical equation of measurements derived from different test objects. Hück,[9] Volkmann,[10] Aubert and Foerster,[12] Dor,[24] Dobrowolski and Gaine,[25] Königshöfer,[26] Charpentier,[27] Hirschberg,[28] Schadow,[29] Butz,[30] Groenouw,[16] Wertheim,[13] Bloom and Garten,[31] Fick,[32] Katzenellenbogen,[33] Calderaro,[34] Wey-

23. Pergens, E.: Recherches sur l'acuité visuelle, Ann. d'ocul., 1906-1913, vols. 135-149. (This is a series of 15 papers on the history of visual acuity.)

24. Dor, H.: Beiträge zur Elektrotherapie der Augenkrankheiten, Arch. f. Ophth. **19**:316, 1873.

25. Dobrowolski, V. I., and Gaine, A.: Über die Sehschärfe (Formsinne) an der Peripherie der Netzhaut, Arch. f. d. ges. Physiol. **12**:411, 1875.

26. Königshöfer, O.: Das Distinktionsvermögen der peripheren Teile der Netzhaut, Inaug. Diss., Erlangen, 1876.

27. Charpentier, A.: De la vision avec lec diverses partiés de la rétine, Arch. de Physiol. norm. et path. **4**:894, 1877.

28. Hirschberg: Über graphische Darstellung der Netzhautfunktion, Arch f. Anat. u. Physiol., Physiol. Abt., 1878, p. 324.

29. Schadow, G.: Die Lichtempfindlichkeit der peripheren Netzhauttheile im Verhältniss zu deren Raum- und Farbensinn, Arch. f. d. ges Physiol. **19**:439, 1878-1879.

30. Butz, K.: (*a*) Vorlaüfige Mittheilungen über Untersuchungen der physiologischen Functionen der Peripherie der Netzhaut, Arch. f. Anat. u. Physiol. 1881, p. 437; (*b*) Untersuchungen über die physiologischen Functionen der Peripherie der Netzhaut, Dorpat, H. Laakmen, 1883.

31. Bloom, S., and Garten, S.: Vergleichende Untersuchung der Sehschärfe des hell- und des dunkeladaptierten Auges, Arch. f. d. ges Physiol. **72**:372, 1898.

32. Fick, A. E.: Stäbchensehschärfe und Zapfensehschärfe, Arch. f. Ophth. **45**:336, 1898. (This paper is a detailed report of the work of Fick's pupil, F. Koester, who published a briefer versi[illegible] [Koester, F.: Über Stabchen- und Zapfensehschärfe, Centralbl. f. Physiol. **10**:431, 1896].)

33. Katzenellenbogen, E. W.: Die zentrale und periphere Sehschärfe des hell- und dunkeladaptierten Auges, Psychol. Stud. **3**:272, 1907.

34. Calderaro, S.: Contributo allo studio della visione indiretta, Clin. ocul. **13**:1109, 1913.

mouth and associates,[35] Cucchia,[36] Ludvigh,[37] Low, [38] Clemmesen [39] and Mandelbaum and Sloan [40] have reported data which are amenable to conversion by the above methods, the results being presented in charts 1 and 2.

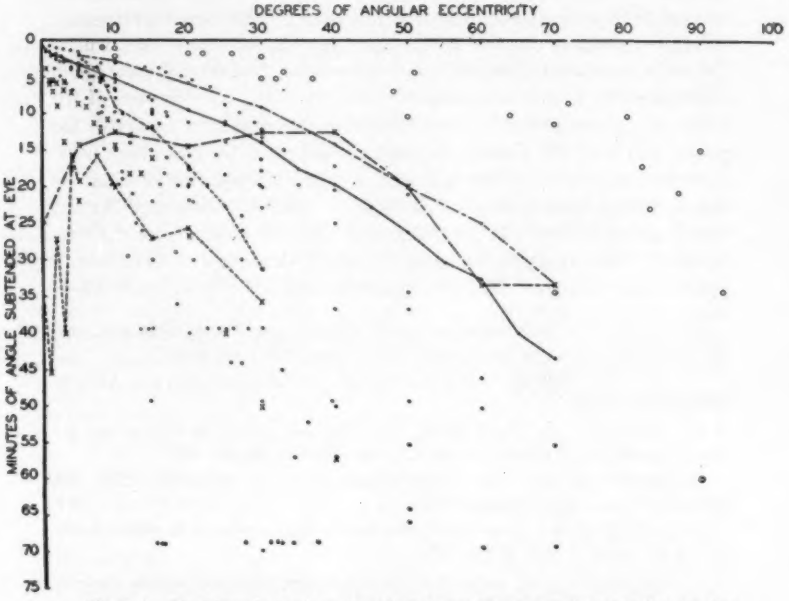


Chart 1.—Peripheral visual acuity plotted against the angle subtended by the test object or its discriminable portion at the eye. Hollow circles represent form field measurements; dots, photopic acuity measurements, and crosses, acuity measurements obtained with scotopic or intermediate brightnesses. Data from certain investigations are connected by lines, as follows: solid line, Wertheim [18]; long and short dashes, Fick [32]; line of dashes, Mandelbaum and Sloan.[40]

35. Weymouth, F. W., and others: Visual Acuity Within the Area Centralis and Its Relation to Eye Movement and Fixation, Am. J. Ophth. **11**:947, 1928.

36. Cucchia, A.: L'acutezza visiva indiretta in condizioni fisiologische, Boll. d'ocul. **9**:1077, 1930.

37. Ludvigh, E.: Extrafoveal Acuity as Measured with Snellen Test Letters, Am. J. Ophth. **24**:303, 1941.

38. Low, F. N.: (*a*) The Peripheral Visual Acuity of 100 Subjects, Am. J. Physiol. **140**:83, 1943; (*b*) The Peripheral Visual Acuity of 100 Subjects Under Scotopic Conditions, ibid. **146**:21, 1946.

39. Clemmesen, V.: Central and Indirect Vision of the Light Adapted Eye, Acta physiol. Scandinav. (supp. 27) **9**:1, 1944.

40. Mandelbaum, J., and Sloan, L. L.: Peripheral Visual Acuity, Am. J. Ophth. **30**:581, 1947.

In chart 1 are plotted peripheral acuities at different angular deviations directly against the angle subtended. Chart 2 represents the same acuities, plotted as reciprocals of their angular measure, normal

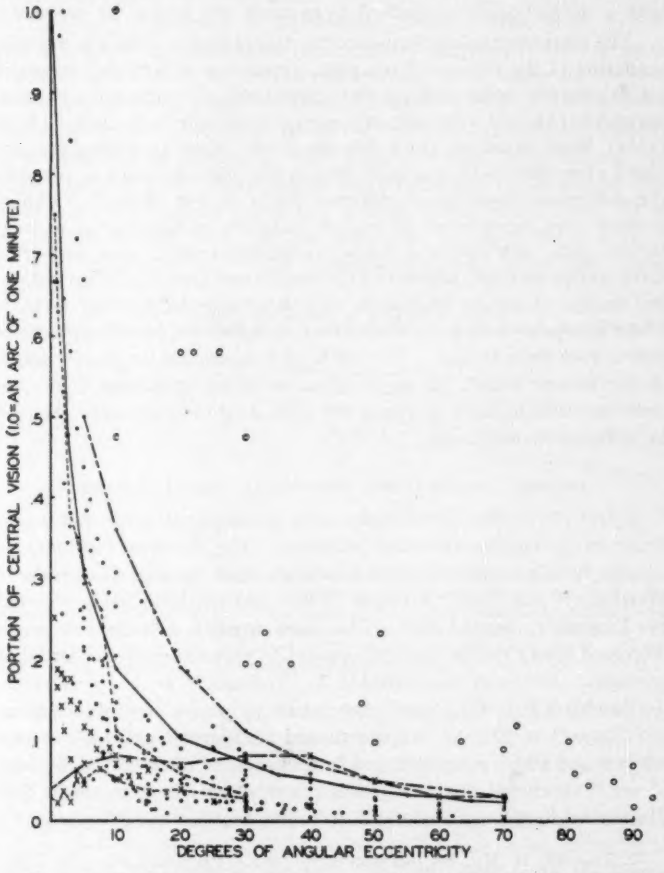


Chart 2.—Peripheral visual acuity compared with central vision. Hollow circles represent form field measurements; dots, photopic acuity measurements, and crosses, acuity measurements obtained with scotopic or intermediate brightnesses. Data from certain investigations are connected by lines, as follows: solid line, Wertheim [18]; long and short dashes, Fick [32]; line of dashes, Mandelbaum and Sloan.[40]

central acuity here being 1. The latter representation was introduced by Wertheim [18] and is responsible for the current view that peripheral

acuity decreases rapidly at first and then more slowly as the far periphery is reached. This is correct only when peripheral acuity is expressed as a fractional value of central acuity. In chart 1, in which the angular measure is used directly, the initial decrease is observed to be gradual with a definite tendency toward more rapid loss in the far periphery.

The most outstanding feature of the data in charts 1 and 2 is the wide scattering of the results. Even after elimination of both (*a*) measurements obtained under scotopic or intermediate brightness and (*b*) measurements obtained with manually operated test objects in motion (form fields), those remaining are widely dispersed. Poor agreement has persisted even after recalculation of data to eliminate, as much as possible, the differences traceable to different kinds of test objects. Original sources were reexamined to achieve judicious elimination of unsatisfactory data, but this was found to be impractical, since no single investigation took into account all the factors now known to affect peripheral acuity. A few investigations, their data connected by lines in charts 1 and 2, appear to be more satisfactory than the rest, but the agreement among even these is poor. This led to an examination, in greater detail, of the factors known or suspected to influence peripheral acuity, in order to evaluate more precisely the conflicting measurements obtained by different investigators.

FACTORS INFLUENCING PERIPHERAL VISUAL ACUITY

Effect of Angular Eccentricity.—All investigators agree that acuity decreases as angular deviation increases. The decrease continues as far peripherally as measurements have been made, those of Charpentier,[27] Wertheim[28] and Fick[32] reaching to 70° and the form fields reported by Traquair[41] beyond 90°. The least angular deviation at which decreased acuity can be detected appears to depend largely on technical precision. Decrease was detected by Volkman[10] at 1° eccentricity, by Burchardt[42] (1871) at ½° but not at ¼° or ⅓°, by Mandelbaum and Sloan[40] at ½°, by Weymouth and associates[38] at 21.27′ in two subjects and 10.64′ in another and by Clemmesen[39] at 2′ 40″. Adler and Meyer[43] concluded that acuity was practically constant to almost 29′. The normal fixation oscillation (2′, according to Adler and Fliegelman[44])

41. Traquair, H. M.: An Introduction to Clinical Perimetry, ed. 6, St. Louis, C. V. Mosby Company, 1949.

42. Burchardt, cited by Köllner.[18]

43. Adler, F. H., and Meyer, G. P.: The Mechanism of the Fovea, Tr. Am. Ophth. Soc. **33**:266, 1935.

44. Adler, F. H., and Fliegelman, M.: Influence of Fixation on the Visual Acuity, Am. J. Ophth. **12**:475, 1934.

should be considered when measurements very close to the axis are being interpreted. Chart 3 presents data for small angular deviations from six investigations. It may be compared with chart 1, since both are plotted against angular units.

Effect of Differences in Meridional Acuity.—Hück [9] and Aubert and Foerster [12] recognized that differences in meridional acuity existed. Hirschberg [28] named the curves representing equal acuity on all field meridians "isopters," and Wertheim [13] mapped them. They are ovals following the normal limits of the visual fields, flattened above (weakest acuity), with their greatest extent (strongest acuity) temporally on the horizontal meridian. According to the illustrations of Weymouth and associates [35] the isopters posses this form at eccentricities of only 10′ to 20′, which are the least angular deviations at which these workers detected reduced acuity. The temporal horizontal meridional acuity

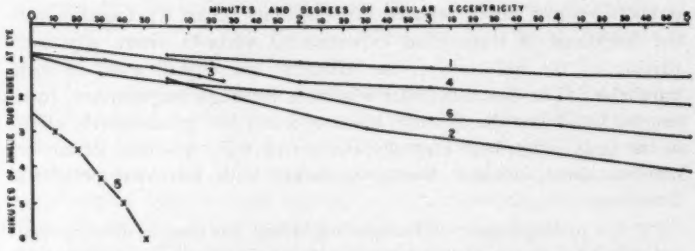


Chart 3.—Peripheral visual acuity from 0° to 5° plotted against the angle subtended by the test object or its discriminable portion at the eye. Dots are measurements obtained with photopic brightnesses, and crosses, those obtained with intermediate brightnesses. The investigations represented are numerically designated as follows: *1*, Hück [9]; *2*, Hirschberg [28]; *3*, Weymouth and associates [35]; *4*, Ludvigh [37]; *5*, Clemmesen [39]; *6*, Mandelbaum and Sloan.[40]

is about twice as strong as that directly above the axis. Differences between the temporal and the nasal horizontal meridional acuities, from which the data of charts 1, 2, 3 and 4 were derived, are of a lesser order, 6:5 representing the most disparate ratio.

Effect of Test Object Differences.—Hück [9] and Volkmann [10] determined both the minimum visible point (black circles on white background) and the minimum separable for lines. Both found the former to be the stronger. At 2° Hück's ratio of acuities was 1:2.4 and Volkmann's 1:4.5. As angular deviation increased, these ratios did not remain constant but became fractionally smaller, there being disproportionate separation of the two measurements. Such separation with increasing angular deviation is also noticeable in the curves of Clemmesen,[39] who measured vernier acuity, the minimum separable

(for luminous and nonluminous squares) and the form threshold (triangles and squares). He concluded that from 0° to 5° vernier acuity was the strongest by a considerable margin, followed in order by the minimum separable and the form acuity. Vernier acuity improved slightly with the length of the line, as did the minimum separable with the size of the squares. The peripheral identification of lines and geometric figures was studied by Salaman,[45] Zigler and associates,[46] Collier,[47] Munn and Geil [48] and Whitmer.[49] Lines could be identified farther peripherally than geometric figures. Among regular polygons the difficulty increased with the number of sides. Circles, parallelograms and diamonds were harder than equilateral triangles but easier than hexagons and octagons.

The above studies afford direct comparison of values obtained with different test objects in single investigations, in which other conditions are presumed to have been kept constant. The gross quantitative differences evident among isolated investigations (chart 2), together with the likelihood of unspecified experimental variants, make any comparison of the influence of the different test objects used in them unreliable. The direct evidence available, although fragmentary, justifies the belief that the different kinds of acuity are quantitatively alined in the same order, both centrally and peripherally, and that differences between them increase disproportionately with increased peripheral deviation.

Effect of Brightness.—Photopic brightness was used by most investigators, although quantitatively unspecified in most cases. Volkmann [10] and Aubert and Foerster [12] used an electric spark in a darkened room. Later, Butz [30a] used a petroleum lamp and Wertheim [18] a gas flame, both of which sources must have insured fairly constant photopic illumination of the test object. Scotopic brightness during the actual discriminations was used by Fick,[32] Bloom and Garten,[31] Katzenellenbogen,[38] Mandelbaum and Sloan [40] and others. At scotopic brightness there is a central scotoma of about 1°, which, of course, possesses zero acuity. From zero at the axis scotopic acuity first increases and then begins

45. Salaman, M.: Some Experiments on Peripheral Vision, Medical Research Council, Special Report Series, no. 136, London, His Majesty's Stationery Office. 1929.

46. Zigler, M. J., and others: The Perception of Form in Peripheral Vision, Am. J. Psychol. **42**:246, 1930.

47. Collier, R. M.: An Experimental Study of Form Perception in Indirect Vision, J. Comp. Psychol. **11**:281, 1931.

48. Munn, N. L., and Geil, G. A.: A Note on Peripheral Form Discrimination, J. Gen. Psychol. **5**:78, 1931.

49. Whitmer, C. A.: Peripheral Form Discrimination Under Dark Adaptation, J. Gen. Psychol. **9**:405, 1933.

to fall again at from 10° to 40° eccentricity. Bloom and Garten [31] and Katzenellenbogen [38] found the peak at 1° to 3° eccentricity; Mandelbaum and Sloan,[40] at 5° to 10°, and Fick,[32] at close to 40°, he being the only investigator to claim superiority over photopic measurements for scotopic acuity (charts 1 and 2). Sloan and Rowland [50] found the strongest scotopic acuity to vary in 18 subjects from 4° to 12° eccentricity. At deviations greater than 30° the difference between photopic and scotopic acuity may be considered negligible. Peripheral acuity at intermediate brightnesses (—4.7 to 0 log millilamberts) was measured by Mandelbaum and Sloan,[40] who found that the acuity increased with the brightness to a maximum at —1 to 0 log millilamberts near the fovea. At eccentricities greater than 20° the increase was small, reaching ing its maximum at a brightness of —2 to —3 log millilamberts.

Indirect evidence on the form of the scotopic isopters is found in the contributions of Østerberg,[51] Sharpley,[52] Low [38b] and Mann and Sharpley.[53] Available evidence favors the belief that the differences in meridional acuity are less, the scotopic isopters thus being more nearly circular than the oval, photopic ones.

The studies cited above, using scotopic and intermediate acuities, were made with the adaptive process stabilized for whatever brightnesses were used, except for the work of Bloom and Garten.[31] These workers made measurements at scotopic brightnesses in both light-adapted and dark-adapted eyes, without realization of the time element involved in dark adaptation. Their irregular results revealed a tendency for acuity to improve as dark adaptation progressed. Low [54] studied the development of scotopic acuity in light-adapted subjects. The scotopically illuminated test object became visible in from one to 7½ minutes, after which maximal acuity took an average of from six to 12½ minutes to develop. At an eccentricity of 15° the process took twice as long as at that at 45°. In a later study (Low [55]) brightness was suddenly lowered 2.8 log units from + 1.2 log millilamberts, the resultant brightness being still suprathreshold. Frequency of seeing at eccentricities of 30° and 45° was significantly reduced, recovering slowly as dark adaptation progressed.

50. Personal communication to the author.

51. Østerberg, G.: Some Researches on the Peripheral Limits of the Field of Vision of the Dark Adapted Eye, Acta ophth. **11**:204, 1933.

52. Sharpley, F. W.: Relation Between Illumination and Extent of the Visual Field, J. Physiol. **105**:215, 1946.

53. Mann, I., and Sharpley, F. W.: (*a*) The Normal Visual (Rod) Field of the Dark-Adapted Eye, J. Physiol. **104**:384, 1946; (*b*) **106**:301, 1947.

54. Low, F. N.: The Development of Peripheral Visual Acuity During the Process of Dark Adaptation, Am. J. Physiol. **146**:622, 1946.

55. Low, F. N.: Effect of Suprathreshold Changes in Brightness on Form Perception, Am. J. Physiol. **155**:409, 1948.

Previous adaptation to bright light (+ 2.7 log millilamberts for 1¾ hours with pupils dilated) increased the severity of the loss and prolonged the recovery.

Magnitude of Individual Differences.—The investigations of Low [56] were made on groups of from 43 to 100 subjects, chosen at random except for the exclusion of evident pathological conditions of the eyes. Acuity measurements varied from 43 to 364 per cent of the mean in photopic brightness,[56a] from 67 to 175 per cent in scotopic brightness [56b] and from 56 to 296 per cent in photopic brightness with moving test objects.[56d] Limitation of viewing time from 1 to 1/100 second, although reducing the acuity, did not noticeably affect the dispersion of scores.[56e] The significance of this variation is treated in more detail in a later section.

Effect of Practice.—Improvement in peripheral acuity through practice was noticed by von Graefe [57] and systematically studied by Dobrowolski and Gaine,[25] whose subjects, trained one hour daily for 3½ months, improved for the first six weeks. The diameters of the isopters of their subjects were about doubled. More recently, Low [56b, c] trained 43 subjects for 25 to 30 hours, over 14 weeks. The acuity increased to 334 per cent of the initial mean, varying among individual subjects from 200 to 1,200 per cent. The improvement was transferred to unfamiliar test objects, unpracticed retinal areas, limited viewing time, night visual acuity and nonlaboratory situations in everyday life (walking, driving, sports, reading). The principal requirements for success in such training are (1) long-continued practice, (2) forced fixation, (3) unlimited viewing time and (4) stationary test objects.

Effect of Spontaneous Fluctuation.—Irregularity of response to constant sensory stimuli is well recognized in physiological and psychological literature, having been observed in peripheral vision even before quantitative measurements were attempted (Troxler,[6] Brewster [7]) and by many investigators since. It is made conspicuous by technics requiring multiple stimulus presentation along with recording of all responses, however illogical. With such technics the successive testing of different peripheral areas demonstrates such fluctuation in the form of irregular spells of good, bad or indifferent acuity scores. The magnitude of the

56. (*a*) Low, F.[38]; (*b*) Some Characteristics of Peripheral Visual Performance, Am. J. Physiol. **146**:573, 1946; (*c*) Effect of Training on Acuity of Peripheral Vision, Report 68, Civil Aeronautics Administration, Division of Research, Washington, D. C., 1946; (*d*) The Peripheral Motion Acuity of 50 Subjects, Am. J. Physiol. **148**:124, 1947; (*e*) Peripheral Visual Acuity of 55 Subjects Under Conditions of Flash Presentation, ibid. **151**:319, 1947.

57. von Graefe, A.: Über die Untersuchung des Gesichtfeldes bei amblyopischen Affectionen, Arch. f. Ophth. **2**:258, 1856.

fluctuation has been expressed as percentile steadiness (Low [56b]), so that a perfectly steady performance lasting 30 to 60 minutes would score 100 per cent. In photopic brightness with unlimited viewing time the mean score was 78 per cent, varying in different subjects from 60 to 95 per cent; in scotopic brightness, 84 per cent, varying from 70 to 98 per cent, and with moving test objects, 72 per cent, varying from 54 to 83 per cent. Limitation of viewing time raised the steadiness from 73 per cent, at one second exposure, to 87 per cent, at 1/100 second exposure (Low [56c]). In a group of 43 subjects whose peripheral acuity was trained to 364 per cent of its initial mean score the mean percentile steadiness of the group varied only 5 per cent (Low [56b]). No subject exhibited significantly greater or less steadiness than the rest of the group in a series of seven or eight tests over 14 weeks.

A great body of literature has been devoted to the study of sensory fluctuation, but most of the data reported are not pertinent to problems of visual acuity. The early psychological literature has been reviewed by Heinrich and Chwistek,[58] and the work of Lange,[59] Marbe,[60] Wiersma,[61] Ferree [62] and Clemmesen [39] are representative of the visual studies. The phenomenon has been studied in central vision by Lythgoe and Corkill [63] and Bárány,[64] who expressed it as frequency of seeing. The basic resemblance between central and peripheral fluctuation becomes evident on comparison of the above studies of central vision with the peripheral frequency of seeing curves of Low.[55]

Effect of Refractive Conditions.—The paramount influence of optical conditions on central acuity is so well recognized that it is surprising to find that information about the peripheral situation is largely speculative.

---

58. Heinrich, W., and Chwistek, L.: Über das periodische Verschwinden kleiner Punkte, Ztschr. f. Sinnesphysiol. **41**:59, 1907.

59. Lange, N.: Beiträge zur Theorie der sinnlichen Aufmerksamkeit und der activen Apperception, Phil. Stud. **4**:389, 1888.

60. Marbe, K.: Die Schwankungen der Gesichtsempfindung, Phil. Stud. **8**:615, 1893.

61. Wiersma, E.: Untersuchungen über die sogennanten Aufmerksamkeitsschwankungen, Ztschr. f. Psychol. u. Physiol. d. Sinnesorg. **26**:168, 1901.

62. Ferree, C. E.: (*a*) An Experimental Examination of the Phenomena Usually Attributed to Fluctuation of Attention, Am. J. Psychol. **17**:81, 1906; (*b*) The Fluctuation of Liminal Visual Stimuli of Point Area, ibid. **24**:378, 1913.

63. Lythgoe, R. J., and Corkill, D. E.: Measurement of Visual Acuity, Medical Research Council, Special Report Series, no. 173, London, His Majesty's Stationery Office, 1932.

64. Bárány, E.: A Theory of Binocular Visual Acuity and an Analysis of the Variability of Visual Acuity, Acta, ophth. **24**:63, 1946; Some Statistical Observations on the Methods of Threshold Determination in General, with Particular Regard to Determination of Visual Acuity and Subliminal Addition, ibid. **24**:113, 1946.

Albini [65] placed lenses between the eye and peripherally presented stimuli. He concluded that poor peripheral acuity is traceable to an imperfect optical image but did not report quantitative data to support this conclusion. It is known that the peripheral image is imperfect, chiefly through barrel distortion (Ames and Proctor [66]), but ten Doesschate [67] cited evidence from theoretical calculations, observation of transscleral images and photographs through scleral windows to support his conclusion that the peripheral image is so slightly impaired that the acuity curve cannot thereby be perceptibly altered. Changes in the form field produced by gross variations in the central refractive condition observed by Uschakoff,[68] Pietsch,[69] and Ferree, Rand and Monroe [70] seldom exceeded 2°. Poor correlation between central and peripheral acuity was recognized by Aubert and Foerster.[12] A correlation coefficient of +0.38 for central and peripheral vision at 30° and 60° eccentricity in 200 eyes was reported by Low.[38a] Clemmesen's [39] measurements in the near periphery show wide variation in persons with the same central acuity.

Effect of Color.—The effect of color in the test object on peripheral acuity has been studied by Klug,[71] Calderaro [34] and Fazakas.[72] This problem is complicated by brightness discrimination and spectral sensitivity factors, neither of which was taken into account in the investigations cited. However, the common colors and white yielded nearly the same values, with considerable contradiction among investigators. It seems safe to conclude that test object color is not a significant determinant of peripheral acuity.

Effect of Limitation of Viewing Time.—Some investigators (Volkmann,[10] Aubert and Foerster,[12] Mandelbaum and Sloan [40]) worked

65. Albini, E.: Della visione indiretta della forme et dei colori, Gior. d. r. Accad. di med. di Torino, ser. 3, **34**:657, 1886.

66. Ames, A., and Proctor, C. A.: Dioptrics of the Eye, J. Optic. Soc. America **5**:22, 1921.

67. ten Doesschate, J.: Visual Acuity and Distribution of Percipient Elements on the Retina, Ophthalmalogica **112**:1, 1946.

68. Uschakoff: Über die Grösse des Gesichtsfeldes bei Augen mit verschiedener Refraction, Arch. f. Anat., 1870, pp. 454-483.

69. Pietsch, H.: Die Ausdehnung des Gesichtsfeldes für weisse und farbige Objecte bei verschiedenen Refraktionszustanden, Inaug. Diss., Breslau, 1896; reviewed in Ztschr. f. Psychol. **14**:477, 1896.

70. Ferree, C. E.; Rand, G., and Monroe, M. M.: Errors of Refraction, Age and Sex in Relation to the Size of the Form Field, Am. J. Ophth. **12**:659, 1929; A Study of the Factors Which Cause Individual Differences in the Size of the Form Field, Am. J. Psychol. **42**:63, 1930.

71. Klug, F.: Über Farbenempfindung beim indirekten Sehen, Arch. f. Ophth. **21**:251, 1875.

72. Fazakas, A.: Über die zentrale und periphere Farbensehschärfe, Arch. f. Ophth. **120**:555, 1928.

with limited viewing time but kept it constant, in contrast to the variable viewing time used by others. Grindley,[73] working at 80° eccentricity, found that longer exposures increased the accuracy of peripheral perception. Low [36c] found that shorter exposures, from one to 1/100 second, reduced acuity at all deviations measured from 20° to 60°. At an eccentricity of 30° the measurements averaged 30.3′ for 1 second, 39.9′ for 1/5 second, 52.3′ for 1/25 second and 63.3′ for 1/100 second. A previous mean of 17.9′ had been obtained (Low [36a]) with unlimited viewing time at the same eccentricity with the same test objects. Opposite results were obtained by Clemmesen [39] who measured retinonasal areas from 0° to 5° with exposures varying from 0.07 second to unlimited viewing time, the acuity being better when the viewing time was limited.

Effect of Movement.—Clear distinction must be made between the perception of movement as such and the discrimination of detail in the moving object. The former was compared to central acuity by Basler [74] and to peripheral acuity by Ruppert.[75] Both found that excursions of less extent than those of the discriminable portions of their test objects were perceived as movement. It is now generally accepted (Duke-Elder [22]) that motion can be perceived in excursions shorter than the measure of the minimum distinguishable point on all parts of the retina. Discrimination of detail in moving test objects was measured by Low [36d] with stimuli swinging both inward and outward along the horizontal meridian at the rate of 15° per second. Simple form acuity under these conditions was about half as strong at 30° eccentricity as that with stationary stimuli but deteriorated twice as rapidly as angular deviation increased, to become unmeasurable in 72 per cent of subjects at 60° eccentricity.

Effect of Psychological Factors.—Among the many psychological studies involving peripheral vision, only a few have bearing on acuity. Some workers appear to have observed expressions of phenomena reported under other headings in this paper. These observations were, for the most part, nonquantitative and will not be considered here.

The Aubert-Foerster phenomenon, first reported by these authors in 1857,[12] is an expression of disparity between peripheral acuity and the size of the retinal image produced by the test object. Stimuli forming equal retinal images produced better acuity when near the eye than

73. Grindley, G. C.: Psychological Factors in Peripheral Vision, Medical Research Council, Special Report Series, no. 163, London, His Majesty's Stationery Office, 1931.

74. Basler, A.: Über das Sehen von Bewegungen, Arch. f. d. ges Physiol. **115**:582, 1906.

75. Ruppert, L.: Ein Vergleich zwischen dem Distinktionsvermögen und Bewegungsempfindlichkeit der Netzhautperipherie, Ztschr. f. Psychol. u. Physiol. d. Sinnesorg. **42**:409, 1908.

when farther away. Kreiker [76] and Freeman [77] claimed that experimental conditions were responsible for the phenomenon, the latter investigator even having succeeded in reversing the discrepancy. Luckiesh and Moss [78] also denied the existence of the phenomenon, but Jaensch and Kleeman [79] supported it. The observed acuity differences are both small and irregular. Musylev [80] concluded that peripheral visual acuity, if measured with proper experimental safeguards, depends on the size of the retinal image. His opinion is probably correct.

Grindley [73] studied psychological factors affecting peripheral vision. He observed illusions of partial illumination, movement, position and size. When attention was previously directed to the portion of the field in which the test object would appear, the number of correct discriminations was increased by 61 per cent. Past experience also increased efficiency. His results are in general accord with those of the peripheral figure reading study of Meisenheimer,[81] whose interpretations support gestalt psychology. The tachistoscopic study of Cattell,[82] involving the axis and near periphery, showed words to be three times as recognizable as random series of letters, and sentences twice as recognizable as random series of words.

Subjective judgment of the correctness of responses to peripheral stimuli was studied by Low.[55] It was found that the number of responses that the subject was certain had been correct was somewhat less than the number of correct responses. When frequency of seeing was either 0 or 100 per cent, the performance and confidence scores coincided, but in the middle percentile range the physiological performance was, in terms of percentile frequency of seeing, about 10 per cent greater than the subjective confidence score.

---

76. Kreiker, A.: Über das Aubert-Förstersche Phänomen auf Grund experimenteller Untersuchungen nebst einigen Bemerkungen über die Eigenschaften des Gesichtsfeldes, Arch. f. Ophth. **118**:292, 1927.

77. Freeman, E.: Anomalies of Peripheral Visual Acuity, J. Exper. Psychol. **12**:324, 1929; Untersuchungen über das indirekte Sehen (speziell z. Analyse des Aubert-Försterschen Phänomens), Psychol. Forsch. **14**:332, 1931; Anomalies of Visual Acuity in Relation to Stimulus-Distance, J. Optic. Soc. America **22**:285, 1932.

78. Luckiesh, M., and Moss, F. M.: The Dependency of Visual Acuity upon Stimulus Distance, J. Optic. Soc. America **23**:25, 1933.

79. Jaensch, E., and Kleeman, R.: Über das Aubert-Försterschen Phänomen und den Zweikomponentsatz in der Lehre von der peripheren Sehschärfe, Arch. f. d. ges. Psychol. **84**:521, 1932.

80. Musylev, F. I.: Die Abhängigkeit der Sehschärfe von der Entfernung des Objektes, Acta ophth. **15**:216, 1937.

81. Meisenheimer, J.: Experimente im peripheren Sehen von Gestalten, Arch. f. d. ges. Psychol. **67**:1, 1929.

82. Cattell, J. M.: Ueber die Trägheit der Netzhaut und das Sehcentrums, Phil. Stud. **3**:95, 1886.

Effect of Other Factors.—Ferree, Rand and Monroe [70] decided that age did not alter the size of the form fields until after 40, the reduction then being small. Sex was not a significant factor. Low's [88a] 100 subjects did not show consistent age differences. In this group and the later training group [56c] the women's scores were poorer than the men's, but with large overlap of their distributions. Ferree, Rand and Sloan [83] observed small contractions in the form field when the pupil was artificially constricted.

COMMENT

No single investigation has controlled all of the factors known to affect peripheral acuity. Many original sources omit pertinent experimental data. Nevertheless, on the basis of the evidence in the foregoing paragraphs, it is possible to form a reasonable interpretation of the gross quantitative discrepancies evident in chart 1.

Peripheral angular deviation is always clearly specified and is not a source of error except, possibly, in areas very close to the axis. The horizontal meridian, either nasal or temporal, has customarily been used, but acuity differences between these two locations are negligibly small, and hence not a source of error. Age, sex, pupillary size, test object color and refractive conditions all produce little change in acuity when varied. They can also be considered negligible. Movement, psychological factors and adaptive phenomena are likely to have been stabilized unless purposely altered, and may be ignored as sources of error. Although practice can produce great improvement, it is slow, and its influence is most unlikely to be significant. Spontaneous fluctuation always operates and cannot be wholly discarded. However, where different eccentricities have yielded data falling into a smooth acuity curve, fluctuation has probably not been significant. Limitation of viewing time affects peripheral acuity, but only very short exposures produce radical changes. Most investigators permitted unlimited viewing time. Test object brightness has its greatest effect near the axis, but there is a noticeable clustering of photopic acuity values toward a central acuity of 1′, indicating good stability among these. Different test objects are a significant source of discrepant acuities. Whenever they have been directly compared, their differences have been numerically large at small eccentricities and disproportionately greater farther out.

Individual variability among a group of subjects is the most likely source of discrepancy. I have paid particular attention to this feature of peripheral acuity and have drawn on unpublished detail of an early

83. Ferree, C. E.; Rand, G., and Sloan, L. L.: The Effect of Size of Pupil on the Form and Color Fields, J. Gen. Psychol. **10**:83, 1934.

study (Low [38a]) to construct the curves of chart 4. Acuity determinations with Landolt circles were made on 100 unselected subjects, centrally and at eccentricities of 30°, 60° and 90°. The center curve represents the mean acuity for the 100 subjects. The distance between the top and the bottom curves embraces the acuities of 90 per cent of the group. The ordinate of chart 4 is extended to 137′, the measurement of the discriminative portion (10 mm.) of the largest test object used; and this must be taken into account when comparing this chart with the data plotted in chart 1, which extends only to 75′. The 90 per cent limits of chart 4 include almost all of the photopic measurements represented in chart 1. The minimum legible was measured in the three investigations showing weaker acuity, Dobrowolski and Gaine [25] and

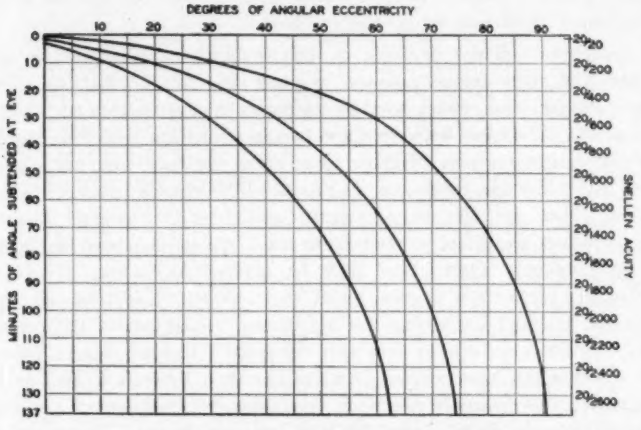


Chart. 4.—Dispersion of peripheral visual acuity scores on the temporal horizontal meridian of the visual field. The upper and lower curves embrace 90 per cent of scores. The middle curve is the average acuity in the group of 100. The width of the break in Landolt circles was used to calculate the angle subtended at the eye.

Konigshöfer [26] having used Snellen type and Aubert and Foerster [12] numbers. The measurements of Hück,[9] who used a black spot on a white ground and those of Fick,[32] who used Steiger prongs, show very slightly better acuity at some angular deviations. It is likely that acuities outside the range of chart 4 are due mainly to the kind of test objects used and, possibly, to chance occurrence of subjects with acuity better or worse than that prescribed by the 90 per cent range.

It appears, then, that chart 4 represents the limits within which peripheral acuity can reasonably be expected to vary in an unselected

group if measured as simple form acuity. For convenience, the acuities for various angular deviations are expressed as Snellen acuities in the accompanying table. For any angular deviation the denominator of the Snellen notation indicates the distance, in feet, at which the discriminable portion of the test object would subtend an arc of 1 minute. For example, at 20° the eye with average peripheral acuity can resolve a test object the discriminable portion of which subtends an angle of about 10′, and which could be read 200 feet (60 meters) away centrally by a normal (20/20) eye. Conversely, the eye with average peripheral acuity can resolve at 20° deviation as well as a 20/200 eye can centrally. The range of peripheral acuity for small angular deviations on chart 4 must be interpreted with caution, since the correlation of acuity in the near periphery with central acuity is not known and the curves are drawn by inspection from 0° to 30°. However, from 0° to 5° the

Peripheral Visual Acuity Expressed in Snellen Notations

Eccentricity	0°	2½°	5°	7½°	10°	15°	20°	25°	30°
Good *.....	20/8	20/14	20/22	20/32	20/45	20/75	20/110	20/150	20/190
Average.....	20/30	20/40	20/60	20/85	20/110	20/150	20/200	20/270	20/355
Poor *.....	20/60	20/85	20/115	20/150	20/190	20/265	20/365	20/480	20/600

Eccentricity	35°	40°	45°	50°	55°	60°	70°	80°	90°
Good *.....	20/240	20/290	20/355	20/420	20/500	20/600	20/940	20/1440	20/2580
Average.....	20/450	20/555	20/690	20/850	20/1050	20/1285	20/2000	.....†	.....†
Poor *.....	20/770	20/960	10/1180	20/1440	20/1780	20/2275	.....†	.....†	.....†

* This range embraces 90 per cent of subjects.
† Acuity unmeasurable.

limits of chart 4 embrace all the photopic measures of chart 3, a circumstance supporting the range represented. Some allowance ought be made for the type of acuity represented. If measurements are made with very simple test objects (minimum distinguishable point; minimum separable points or lines), then the acuity would be better and the curves raised. If test objects requiring more complex discriminations are used, such as the letters and numbers required for measurement of the minimum legible, then the curves would be lowered through poorer acuity. The effect of peripheral training, which has been shown to bring measurements to 334 per cent of the starting value (Low [56b, c]), can be estimated by raising the center curve to a point represented by the minutes of angle subtended for any angular deviation, divided by 3.34. In these hypothetical alterations, raising the curves would contract the dispersion somewhat, bringing them close together. Lowering them would cause greater dispersion and consequent separation.

The normal range of scotopic acuity is more difficult to formulate, although the general trend is clear. Differences between scotopic and photopic acuity are greatest at the axis and become less as eccentricity increases. At small eccentricities data on both acuity and normal variability are inadequate. At 30° and 60° eccentricity normal variability seems to be somewhat less (Low [38b]) than for comparable photopic measures (Low [38a]).

Differences between photopic and scotopic measurements are easily reconciled with physiological phenomena (Hecht [84]) and regional retinal anatomy (Østerberg [85]). Improvement with practice, large in the periphery, is a recognized characteristic of central acuity as well (Bruce and Low [86]). The relatively unpracticed status of the peripheral retina probably accounts for the difference. The poor correlation between peripheral acuity and the optical situation contrasts with the well recognized high correlation of optics with central acuity and is the most difficult feature of peripheral acuity data to interpret. Centrally a sharp image is necessary for full utilization of the fine retinal grain. It seems possible that as the retinal grain coarsens peripherally, it does so more extensively than the corresponding deterioration of the optical image, so that the moderately poor image is adequate for maximal acuity in peripheral areas. Certainly, a sharp image here could not produce acuity beyond the potentialities of the grain itself. Hence, wide variations of image fidelity could presumably be tolerated in the periphery without corresponding changes in acuity. It is known that gross variations exist (Ferree, Rand and Hardy [87]), but corresponding measurements of acuity are, unfortunately, not available. The clarification of this problem awaits systematic investigation.

The characteristics of peripheral visual acuity discussed herein all have a counterpart in central acuity. Centrally many of these features are inconspicuous, being quantitatively small in the presence of high

84. Hecht, S.: Rods, Cones and the Chemical Basis of Vision, Physiol. Rev. **17**:239, 1937.

85. Østerberg, G.: Topography of the Layer of Rods and Cones in the Human Retina, Acta ophth., supp. 6, p. 1, 1935.

86. Bruce, R. H., and Low, F. N.: The Effect of Practice with Brief Exposure Techniques upon Central and Peripheral Visual Acuity and a Search for a Brief Test of Peripheral Acuity, to be published.

87. Ferree, C. E.; Rand, G., and Hardy, C.: Refraction for the Peripheral Field of Vision, Arch. Ophth. **5**:717 (May) 1931. Ferree, C. E., and Rand, G.: The Refractive Conditions for the Peripheral Field of Vision, in Report of a Joint Discussion on Vision, Physical and Optical Societies, London, Cambridge University Press, 1932; Interpretation of Refractive Conditions in the Peripheral Field of Vision, Arch. Ophth. **9**:925 (June) 1933.

acuity. All available evidence indicates that they bear the same essential relationship to each other and to acuity itself as in the periphery. In the far periphery their study is facilitated by relative freedom from optical and brightness factors and by the gross measurements incident to poor acuity. Acuity characteristics masked by smallness or by the greater importance of other factors in central vision become conspicuous in the far periphery without other than quantitative change. The differences between peripheral visual acuity and central visual acuity are quantitative, rather than qualitative.

Louisiana State University School of Medicine.

Annual Reviews

LIDS, LACRIMAL APPARATUS AND CONJUNCTIVA

Review of Recent Literature

JAMES H. ALLEN, M.D.
NEW ORLEANS

LIDS

Treatment of Hordeolum.—For the treatment of hordeolum, Rosas Costa [1] makes an intrapalpebral injection of 50,000 units of penicillin in 1 to 1.5 ml. of 2 to 4 per cent procaine after the site has been cooled with ice for 10 to 15 minutes. Stern [2] advocates the injection of 10 ml. of autogenous venous blood into the muscles of the thigh in the patient. Both measures seem heroic for the majority of cases of sty, and even in cases of recurrent or repeated attacks of sty specific immunization therapy with toxoid and vaccine, the use of hot compresses and local applications of tyrothricin or 15 to 30 per cent sulfacetimide sodium have proved rapidly effective. With severe or persistent attacks, the general physical status of the patient should be investigated, as such attacks are sometimes the first indication that the patient has a chronic debilitating disease.

Blepharitis.—Couzi [3] recognizes that in the majority of cases blepharitis is due to staphylococci and suggests that errors of refraction should be corrected, even though they cannot be regarded as an etiologic factor. Petrov [4] reports good results from the daily use of a 4 per cent alcoholic solution of gramicidin by applicator for seven to 10 days. Seoud [5] injected 0.5 to 1 ml. of an emulsion of 0.5 per cent yellow mercuric oxide in olive oil in resistant cases of chronic ulcerative blepharitis. He reports that the condition of the majority of 50 patients was improved and that some were cured.

Angular Blepharitis.—Chen [6] reports that fissuring of the external canthi may be a result of riboflavin deficiency and that administration of 6 mg. of riboflavin daily produces rapid improvement in cases of this type without local treatment. Among 97 prisoners in Nanking, 23 had the classic manifestations of ariboflavinosis; and of these, 4 showed fissuring of the external canthi.

Tulane University of Louisiana School of Medicine.

1. Rosas Costa, M. T.: Treatment of Hordeolum by Intrapalpebral Injection of Penicillin. An. argent. de oftal. **8**:13-16, (Jan.-March) 1947.

2. Stern, H. J.: Autohaemo-Therapy in Hordeolosis, Brit. J. Ophth. **31**:766-769 (Dec.) 1947.

3. Couzi, J.: Staphylococcic Blepharitis, Ann. d'ocul. **181**:274-292 (May) 1948.

4. Petrov, A. G.: Gramicidin in Therapy of Ulcerative Blepharitis, Vestnik oftal. (no. 6) **26**:43 (June) 1947.

5. Seoud, G. A.: A New Method of Treating Blepharitis by Local Injections, Bull. Ophth. Soc. Egypt **35**:55-56, 1942.

6. Chen, T. T.: Angular Blepharitis in Ariboflavinosis—A Not Well Known Clinical Manifestation of Riboflavin Deficiency, Chinese M. J. **66**:1-4 (Jan.) 1948.

Streptomycin Sensitivity.—Dufour [7] observed five nurses with eczema of the lids due to the handling of streptomycin. Of these, two had conjunctivitis as well and two others had dermatitis of the fingers. The sensitivity developed after contact with the drug for from three months to a year. Protective measures were ineffective, but local and general treatment had a favorable, although not entirely satisfactory, result.

Anthrax of the Eye.—Barnshaw and Lovett [8] report seven instances of ocular complications in 90 cases of anthrax. In two of the cases there was malignant edema and in five a malignant pustule. All but one of the 90 cases occurred among workers in the leather and wool industry. The type of anthrax with malignant edema is painless, a feature differentiating it from edema due to cellulitis. The pustule of anthrax is characterized by a black center with surrounding vesicles. A smear from the base of the ulcer or from the edema fluid will reveal the organism. Antianthrax serum treatment is now being replaced by the use of sulfonamides. The usual treatment is an initial dose of 5 Gm. of sulfadiazine sodium given intravenously, followed by administration of 2 Gm. every three hours. From 21 to 94 Gm. has been used in the treatment of the disease. Penicillin also is effective in doses of 40,000 units. Under treatment with either drug, the lesion gradually increases in size for two to four days, the edema becoming more pronounced, but beginning to subside on the fourth day. An additional series of four cases are reported by Rundlett.[9] His patients worked in a rug factory.

Leishmaniasis.—Leishmaniasis of the lids was observed by di Ferdinando [10] in a 2 year old child. The lesion was the size of a cherry, reddish brown and covered with a thick crust of blood serum. It had a fibroelastic consistency and furfuraceous squamae. There was no reaction of the lymph nodes. The lesion was cured with two irradiations. Agnello [11] successfully used diathermy coagulation for an ulcer of the prelacrimal region due to leishmaniasis. He [12] also observed four cases of oriental button in the eyelids and face in Nyeri Hospital.

Congenital Anomalies.—Kettesy [13] describes a case of entropion in a 7 week old infant whose eyes had become inflamed on the third postnatal day. Eversion of the lid revealed the tarsus to be fully folded horizontally. The delicate tarsus had become folded as a result of the weight of the inflamed conjunctiva on the convex tarsal margin, while the levator was temporarily paralyzed. The fold became fixed

7. Dufour, R.: Eczema of the Eyelid Due to Streptomycin: A New Occupational Disease in Hospital Attendants, Praxis **37**:427-428 (June 10) 1948.

8. Barnshaw, H. D., and Lovett, J. C.: Anthrax of the Eye, Am. J. Ophth. **32**:106-110 (Jan.) 1949.

9. Rundlett, E. V.: Anthrax of the Eyelid, J. M. Soc. New Jersey **45**:277 (June) 1948.

10. di Ferdinando, R.: A Case of Palpebral Leishmaniasis (Oriental Boil), Gior. ital. oftal. **1**:359-364 (July-Aug.) 1948.

11. Agnello, F.: Diathermy Coagulation in Treatment of Cutaneous Leishmaniasis: A New Contribution on Oriental Sore of the Prelacrimal Region, Gior. ital. oftal. **2**:231-236 (May-June) 1949.

12. Agnello, F.: Clinical, Epidemiological and Therapeutic Considerations on Cutaneous Palpebral "Leishmaniasis," with Reference to Incidence of Kala-Azar and Oriental Button in Nyeri (Kenya), Ann. ottal. e clin. ocul. **74**:129-147 (March) 1948.

13. Kettesy, A.: Entropion in Infancy Caused by Folding of the Tarsus: Report of a Case, Arch. Ophth. **39**:640-642 (May) 1948.

and remained, even though the levator regained its power. The defect was repaired by unfolding the tarsus and splinting it with a 4 mm. gauze roll, attached by two mattress sutures, for five days.

Three cases of congenital elongation of the inferior canaliculi are reported by Malatesta.[14] This anomaly has been described in association with ptosis, epicanthus, abnormal formation or lack of the caruncle and shortness of the palpebral fissure with a broad bridge of the nose and a narrow conjunctival sac. The father of one of the three patients had the same deformity.

Tumors of the Lids.—Carcinoma: Of 50 cases of carcinoma of the lids, which occurred among 1,439 cases of carcinoma of the face, de Castro[15] reported that 37 per cent were of the basal cell type, 12 per cent of the prickle cell type and 12 per cent of the squamous cell type. Two of the patients were school children 7 and 10 years of age. The rest were adults, the oldest being 87 years of age. De Castro[16] believes that radium is the treatment of choice but cites the usual local sequelae which may follow: radium dermatitis, local alopecia, parenchymatous infiltration of the cornea, corneal ulcer, cataract and iridocyclitis. Brückner,[17] in reporting 5 cases, emphasizes that because of the danger to the eyeball less intensive irradiation is being attempted than in the case of skin carcinoma of other regions of the body. He makes the point that postoperative radiation therapy may be used and emphasizes that radical surgical intervention is necessary in advanced stages.

Hirschfelder and Frost[18] report an unusual case of carcinoma of the inner canthus and forehead in a man aged 85, which was treated by the implantation of needles containing 15 mg. of radium for one week. Clinically, the tumor disappeared in two months, and subsequent biopsy showed no signs of tumor tissue.

Radnót[19] describes the recurrence and metastasis to a preauricular lymph node of a carcinoma of a meibomian gland four years after excision. The patient was a man aged 57. Both the recurrence and metastasis were successfully treated with radium.

Xeroderma Pigmentosum.—Saebø[20] reports the occurrence of xeroderma pigmentosum in a brother and sister but concludes that the disease is recessive. He adds a third case from another family to emphasize the relation between pigmented spots in the skin and melanoma of the eye in this disease.

Myxosarcoma of the Eyelid.[21]—A lesion resembling a hematoma appeared two weeks after a 9 year old boy was struck in the eye. Partial resection two weeks

14. Malatesta, C.: Widening of Palpebral Fissure and Lengthening of Lacrimal Duct, Boll. d'ocul. **27**:88-97 (Feb.) 1948.

15. de Castro, M.: Cancer of the Eyelid, Resenha clín.-cient. **17**:344-346 (Sept.) 1948.

16. de Castro, M.: Cancer of the Eyelid, Arq. brasil. de oftal. **11**:90-96 (March) 1948.

17. Brückner, R.: Five Cases of Carcinoma of the Lids and the Oculonasal Region Treated by Operation or by Radium and Roentgen Irradiation, Ophthalmologica **116**:109-110 (Feb.) 1948.

18. Hirschfelder, M., and Frost, J.: Carcinoma of the Inner Canthus and Forehead, Am. J. Ophth. **31**:999-1001 (Aug.) 1948.

19. Radnót, M.: Rare Malignant Tumors of the Eyelids, Gior. ital. oftal. **2**:101-107 (March-April) 1949.

20. Saebø, J.: Xeroderma Pigmentosum with Affection of the Eye, Brit. J. Ophth. **32**:398-411 (July) 1948.

21. Moehle, W.: Myxosarcoma of the Eyelid, Arch. Ophth. **41**:317-323 (March) 1949.

later because of continued growth revealed a myxosarcoma. Intensive radiation therapy was given, and two years later, on removal of the painful phthisical globe, no evidence of the tumor was found.

Lymphosarcoma of the Eyelid.—An unusual case of lymphosarcoma of the lid in a man aged 49 is reported by Stansbury.[22] After a superficial trauma, purulent conjunctivitis, and later swelling of the regional tissues, developed. Within 40 days of the first manifestation of the growth axillary nodes were palpable and the liver was enlarged. The biopsy diagnosis was malignant lymphosarcoma of reticulum cell type. The patient died in acute cardiac distress.

Melanosis of the Eyelids.—Braithwaite [23] reports two cases of melanosis of the lids. In the first case a slate gray pigmentation developed about the left lower lid at the age of 30. After eight years, the pigmentation had spread into the temporal region, and an ulcerated nodule had appeared in the lower lid. The tumor was removed; radon was inserted in the surrounding tissue and a postauricular graft used to close the defect, with good results. The second patient had had a bluish gray discoloration of the right upper and lower lids and surrounding temporal and malar regions from birth. At 12 years of age she was struck in the eye. Biopsy of the swelling of the lower lid revealed a malignant melanoma. Seven years later a diffuse black mass was found to be invading the muscles of the cheek and growing deep into the orbit. Partial excision showed the tumor to be a melanotic sarcoma. The author emphasizes the danger of congenital blue nevi and the importance of removing them in childhood, whereas acquired melanosis is precancerous and carries a good prognosis following excision and radiation therapy.

Multiple Neurofibroma.—Wallach [24] reports a case of multiple neurofibroma composed of the small, hard type of tumors distributed over the palms of the hands, the scalp and the mucocutaneous borders of the upper and lower lids, where they are the cause of recurrent trichiasis. The single, large, soft tumor is the only type previously reported on the lid.

Ptosis.—Berke [25] surveyed 200 consecutive cases of congenital ptosis and found normal function of the superior rectus in 73.5 per cent, weakness of elevation, due to weakness either of the superior rectus or of both the superior rectus and the inferior oblique, in 17 per cent, the Gunn jaw-winking phenomenon in 6 per cent and an associated blepharophimosis in 3.5 per cent. Approximately one half the group with weakness of elevation had an additional anomaly of the extraocular muscles.

Amyot [26] describes nine cases of ptosis coming on after the age of 50. He believes that the ptosis is due to a local myopathic lesion of the levator but with a genetic basis.

---

22. Stansbury, F. C., Lymphosarcoma of the Eyelid: Report of Case, with Death in 40 Days. Arch. Ophth. **40**:518-530 (Nov.) 1948.

23. Braithwaite, F.: Melanosis of the Eyelids, Brit. J. Plast. Surg. **1**:206-211 (Oct.) 1948.

24. Wallach, E. A.: A Case of Multiple Neurofibromatosis with Some Unusual Features. Am. J. Ophth. **31**:1487-1489 (Nov.) 1948.

25. Berke, R. N.: Congenital Ptosis: A Classification of 200 Cases, Arch. Ophth. **41**:188-197 (Feb.) 1949.

26. Amyot, R.: Hereditary, Familial and Acquired Ptosis of Late Onset, Canad. M. A. J. **59**:434-438 (Nov.) 1948.

Lid Surgery.—Tarsorrhaphy: Sarwar [27] describes a new technic for tarsorrhaphy which consists of splitting both lids along the gray line and separating the tarsal plate from the skin and muscle for 3 mm. from the margin. The pretarsal layers of the two lids are united by a continuous mattress suture, which is drawn tight, leaving the ends free. The lash-bearing edges of the lids are sutured together with interrupted mattress sutures tied through 3 mm. lengths of rubber tubing. The continuous suture is removed after 48 hours, and the interrupted sutures are removed on the sixth day.

Ectropion: Németh [28] advocates a technic for correction of ectropion which consists of splitting the lid into anterior and posterior layers just anterior to the tarsus. The anterior layer is lifted temporarily after excision of a crescent of skin over the temple. The posterior layer is left intact, but the lower fornix is pulled down by a suture.

Entropion: Numerous procedures or modifications of operations for entropion are reported. Wessely [29] prepares a band-shaped vertical cutaneous flap near the middle of the lid. He removes triangles of skin and then pulls the flap until the lid takes the proper position, removes the excess of the flap and closes the wounds. Majoros,[30] Pan,[31] Dejean [32] and Chabat [33] divide the tarsus horizontally and by various methods of placing sutures evert the marginal section of tarsus. Zarrabi [34] advocates the removal of a 3 mm. segment of skin and a 1.5 mm. segment of tarsus near the lid border of the upper lid for the correction of entropion in trachoma. He closes the tarsal wound and subcutaneous tissues with a continuous suture but does not suture the skin. Motto and Alexander [35] advocate greater use of Wheeler's orbicularis advancement operation.

Mascati [36] splits the lid and transplants a 2 mm. flap of skin into the intermarginal space from just above the lid border. In the obtaining of this flap, the route is open for the removal of a wedge from the anterior surface of the tarsus if necessary. In extreme cases which do not lend themselves to this plastic correction, the author exposes the hair follicles through a skin incision and destroys them with an electrocautery.

---

27. Sarwar, M.: A Modified Technique of Tarsorrhaphy, Am. J. Ophth. **32**:439-441 (March) 1949.

28. Németh, L.: Surgical Treatment of Ectropion Caused by Blepharadenitis, Ophthalmologica **116**:162-166 (Sept.) 1948.

29. Wessely, K.: Contribution to the Operation for Entropion, Arch. f. Ophth. **148**:358-360 (March-April) 1948.

30. Majoros, J.: Surgical Procedure for Cicatricial Entropion, Acta ophth. **26**:363-371 (March) 1948.

31. Pan, T. H.: Tarsoplastic Method for Correction of Entropion, Nat. M. J. China **34**:5-6, 1948.

32. Dejean, C.: Technical Modifications of Panas' Operation for Entropion and Trichiasis, Arch. d'opht. **8**:353-359 (April) 1948.

33. Chabat, H.: Operation for Trachomatous Trichiasis by the Conjunctival Route (Travut's Method), Arch. d'opht. **9**:48-51 (Jan.) 1949.

34. Zarrabi: Operation for Entropion Arch. d'opht. **8**:269-270 (March) 1948.

35. Motto, M. P., and Alexander, R. L.: Spastic Entropion Correction: Wheeler's Orbicularis Advancement, Am. J. Ophth. **32**:557-560 (April) 1949.

36. Mascati, N. T.: A New Operation for Entropion and Trichiasis of the Upper Eyelids. Indian M. Gaz. **83**:79-81 (Feb.) 1948.

Ptosis: The most rational treatment of ptosis, according to Weekers,[37] consists in reenforcing the levator palpebrae muscle. He reports good results even if the levator is completely inactive, for the operation raises the eyelid and enlarges the palpebral fissure. For ptosis due to chronic inflammation of the lid, as in trachoma, Weekers advocates shortening of the tarsus by diathermy coagulation.

Gardilčić [38] also advocates methods of shortening the levator. However, he thinks that the disadvantages of Blaskovic's technic are that it is difficult to perform, that its effects cannot be predicted and that it cannot be repeated when correction is insufficient. Therefore, he has devised a folding operation on the levator which may be repeated if necessary.

Berke [25] lists the following criteria for a good result in the correction of ptosis:

1. The curve of the margin of the upper lid should overlap the cornea equally on the two sides.
2. The margin of the lid should be a smooth curve and similar in the two eyes.
3. The superior palpebral crease should correspond on the two sides.
4. The eye should be capable of being widely opened and completely closed.
5. Normal winking should be preserved.
6. The vertical distance between brow and upper lid margin should be the same in the two eyes.
7. The upper lid of each eye should move synchronously with the globe in all directions of the gaze.
8. Diplopia or disturbing heterophoria should be absent.

Reconstruction of Contracted Eyelids: Lagrot [39] describes the technic of large free dermoepidermic grafts. With the patient under general anesthesia, adhesions are freed, and bleeding is carefully controlled. A mold of the defect is made with layers of petrolatum U. S. P. (vaseline®) compresses. The graft is taken from the inner side of the arm or thigh, using the automatic razor of Drapier. The graft is then applied to the mold and pressed into the wound. The mold is tied into place for 10 days.

LACRIMAL APPARATUS

Congenital Anomalies.[40]—Woywitka [41] observed nine patients with congenital atresia of the nasolacrimal duct in five generations of a family of 46 members and concludes that the condition is a dominant hereditary defect.

Guerry and Kendig [42] prefer the term congenital impatency of the nasolacrimal duct. They found 12 cases among 200 full term infants, in all of which there was

37. Weekers, L.: Operative Technique for Ptosis: Diathermic Coagulation of the Tarsus, Bull. Soc. belge d'opht. **87**:21-29, 1947.

38. Gardilčić, A.: Operation for Ptosis by Folding the Levator Muscle, Ophthalmologica **115**:269-282 (May) 1948.

39. Lagrot, F.: Reconstruction of Contracted Eyelids by a Free Dermoepidermic Graft (17 Cases), Ann. d'ocul. **182**:32-51 (Jan.) 1949.

40. Thomson, A. M. W.: Diseases of the Lacrimal Sac, M. Press **220**:93-95 (Aug. 4) 1948.

41. Woywitka, N. W.: Congenital Atresia of the Nasolackrymal Duct, Canad. M. A. J. **59**:357-359 (Oct.) 1948.

42. Guerry, D., and Kendig, E. L., Jr.: Congenital Impatency of the Nasolacrimal Duct, Arch. Ophth. **39**:193-204 (Feb.) 1948.

good response to daily massage of the lacrimal sac and local application of penicillin ointment, but they describe five other cases in which probing was required after six months of conservative treatment. On the other hand, Cassady [43] advocates irrigation and early probing. Of 100 of his cases, patency was established after a few days in 67, after a week in 10 and eventually in the remainder; but the delay was due principally to lack of cooperation of the parents. Cassady believes that the dangers of this type of treatment are highly overrated.

Simpson [44] presents a case of bilateral congenital fistula of the lacrimal duct in a 7 year old boy. The lacrimal ducts opened on the face approximately 6 mm. below the inner canthi. A dacryocystorhinostomy was performed successfully on one side, and a similar procedure was planned for the other. The position of the perforations was characteristic and should distinguish this lesion from fistulas of the frontal sinus, which, according to Merten,[45] always occur above the internal canthal ligament.

An unusual congenital anomaly consisting of elongation of the superior and inferior lacrimal canaliculi was reported by Calogero,[46] and Lopez [47] found a tooth in tissue adjacent to the lacrimal sac which he was extirpating.

Tears.—Smolens, Leopold and Parker [48] analyzed tears from 215 volunteers (430 eyes). They found 18.7 mg. of solids per milliliter of tears. Sodium chloride accounted for 4.9 mg., and other dialysable solids, for 4.7 mg., leaving 9.1 mg. of nondialysable solids. By electrophoretic methods four components were separated; components 1, 2 and 3 were positively, and component 4 was negatively charged. Lysozyme activity seemed to be associated with components 2, 3 and 4, but none had the same mobility as crystalline egg white. Because of this, and because anti-egg-white-lysozyme serums failed to inhibit the activity of the lysozyme, it was concluded that they were different. From nitrogen and phosphorus determinations, the authors concluded that little, if any, phosphoproteins or nucleoproteins were present. Sugar, however, was indicated by a positive Molisch reaction, and aromatic amino acids were demonstrated by the ultraviolet absorption spectrum. The authors believe that lysozyme originates either in the lacrimal gland or from the bacterial flora of the conjunctiva.

Cutinelli and Bonavolontà [49] reported that the lytic principle tends to decrease in many diseases, especially when diluted with tears but that it increases in suppurative infections.

---

43. Cassady, J. V.: Dacryocystitis of Infancy, Am. J. Ophth. **31**:773-780 (July) 1948; Dacryocystitis of Infancy: A Review of 100 Cases, Arch. Ophth. **39**:491-507 (April) 1948.

44. Simpson, J. F.: Congenital Bilateral Fistula of Tear Duct: One Side Treated by Toti's Operation, Proc. Roy. Soc. Med. **40**:286 (April) 1947.

45. Merten, A.: About an Enclosed Empyema of the Frontal Sinus with Fistulous Perforation Near the Inner Angle of the Eye, Monatsschr. f. Ohrenh. **81**:298-304 (June) 1947.

46. Calogero, V. N.: Contribution to the Study of "Elongation of the Superior and Inferior Lacrimal Canaliculus," Gior. ital. oftal. **2**:237-242 (May-June) 1949.

47. Lopez, A. A.: Unexpected Findings in Operation for Dacryocystitis, Arch. Soc. oftal. hispano-am. **8**:1046-1054 (Oct.) 1948.

48. Smolens, J.; Leopold, I. H., and Parker, J.: Studies of Human Tears, Am. J. Ophth. **32**:153-160 (June) 1949.

49. Cutinelli, C., and Bonavolontà, A.: Lysozyme in Suppurative Diseases of the Eye, Gior. ital. oftal. **2**:19-25 (Jan.-Feb.) 1949.

Nordenson [50] believes that the siphon theory and the pump action of the lacrimal sac in the transportation of tears should be discarded. He believes that closure of the lids permits the conjunctival sac to act as the body of a forcing pump.

Dacryocystitis and Stenosis.—Theodore [51] emphasizes the soundness of the old teaching of investigating the lacrimal apparatus in cases of chronic conjunctivitis. He believes that irrigation and subsequent examination of the irrigating fluid are the best procedures. However, Toth [52] points out the fundamental difference between spontaneous drainage of tears and forced passage of irrigation fluid. Therefore, he prefers a functional test, consisting of the instillation of 1 drop of 3 per cent collargol® (a preparation of silver oxide and colloidal silver stabilized with derived egg albumin). The speed of disappearance or the type of color band persisting determines the type and location of obstruction.

Mezey [53] describes a bone-free technic of roentgen photography of the lacrimal sac. The film is placed on the orbital rim, after the lacrimal sac has been filled with an opaque medium, and the tube is directed toward the center of the sac from under the contralateral malar bone.

The usual cause of stone formation in the lacrimal canaliculus is Streptothrix (Busina [54] and Papolczy [55]); however, Donahue [56] described a black substance in the case of a white girl aged 12 years which proved to be Aspergillus niger.

Among the unusual causes of obstruction of the canaliculi, Boase [57] found an eyelash in a lacrimal punctum, and Kurz [58] observed a canaliculus closed by pressure from a chalazion. He also found a punctum everted because of lymphoid hyperplasia and a valvelike closure of the wall in an elongated inferior canaliculus. All three of these conditions were relieved by careful surgical attack.

In a study of trachomatous Libyans, Bellecci [59] found that approximately 10 per cent had chronic dacryocystitis and stenosis of the lacrimal passages. Trachomatous involvement of the sac was not always demonstrable histologically.

Primary tuberculosis of the lacrimal sac was found in a schoolboy by El-Marzouki.[60]

---

50. Nordenson, J. W.: Jean-Louis Petit and the Mechanism of the Transportation of Tears, Arch. d'opht. **9**:5-8 (Jan.) 1949.

51. Theodore, F. H.: "Silent" Dacryocystitis, Arch. Ophth. **40**:157-162 (Aug.) 1948.

52. Toth, Z.: Functional Test for the Pre-Lacrimal-Sac Segment of the Lacrimal Apparatus, Klin. Monatsbl. f. Augenh. **113**:158-167 (Feb.) 1948.

53. Mezey, P. I.: New Diagnostic Procedure in X-Ray Photography of the Lacrimal Sac, Szemeszeti Tanulmanyok, 1948, pp. 148-150.

54. Busina, K.: Streptotrichosis of the Lacrimal Passages, Českoslov. ofth. **4**:158-162, 1948.

55. Papolczy, F.: Purulent Inflammation of the Lacrimal Canaliculus Due to Stone Formation, Klin. Monatsbl. f. Augenh. **114**:269-271 (March) 1948.

56. Donahue, H. C.: Unusual Mycotic Infection of the Lacrimal Canaliculi and Conjunctiva, Am. J. Ophth. **32**:207-210 (Feb.) 1949.

57. Boase, A. J.: Eye-Lash in the Lacrimal Punctum, Brit. J. Ophth. **33**:513 (Aug.) 1949.

58. Kurz, O.: Unusual Drainage Disturbances in the Superior Lacrimal Ducts, Ophthalmologica **115**:101-109 (Feb.) 1948.

59. Bellecci, P.: Pathoanatomic Observations on the Lacrimal Sac in Trachomatous Libyans, with Clinical and Etiopathogenetic Notes, Ann. méd. nav., Roma **52**:156-168 (Feb.) 1947.

60. El-Marzouki, M. M.: Two Cases of Primary Tuberculosis of the Eye, Bull. Ophth. Soc. Egypt **35**:141-144, 1942.

Inflammatory Lesions of the Lacrimal Gland.—The seventh case of bilateral tuberculosis of the lacrimal gland was reported by Masini.[61] The patient, a man aged 32, had a history of bilateral apical tuberculosis for four years. The glandular lesions apparently were due to hematogenous spread, because they occurred concurrently. The gland was removed on the right side but was treated by irradiation on the left. The latter method produced the better result.

During an epidemic of dysentery in the Russian campaign, Mildenberger[62] observed complications consisting of joint pains, conjunctivitis and urethritis (Reiter's disease). In some cases this triad appeared without dysentery. In two cases painful inflammation of the lacrimal gland also developed.

Mikulicz' disease (achroacytosis), according to Heath,[63] consists of a granulomatous response of lymphatic tissue of the reticuloendothelial system to a stimulus of either infective or chemical origin. Differential diagnosis from tuberculosis, sarcoidosis, gout, syphilis and giant follicular lymphoplasia should be made on the basis of the general health of the patient, the course of the disease, local ocular findings and the results of biopsy.

Tumors of the Lacrimal Gland.—A woman aged 22 presented downward and inward displacement of the left eye associated with proptosis and limitation of upward rotation. Vrabec[64] found a retention cyst of the orbital part of the lacrimal gland. Charamis[65] noted similar clinical manifestations due to adenocarcinoma of the lacrimal gland in a woman aged 24. Rubin[66] reported a mixed cell tumor, and Cosmettatos[67] and Grom[68] each reported a case of carcinoma of the lacrimal gland, while MacMillan[69] reported three cases.

Surgery of the Lacrimal Sac.—Dacryocystorhinostomy has become the operation of choice for chronic dacryocystitis, but it is also indicated in the case of dacryostenosis without infection, incomplete surgical removal of the sac and lacrimal fistula.[70] It is contraindicated in cases of acute dacryocystitis, permanent obstruction of the inferior canaliculus, such associated diseases as syphilis and tuberculosis, tumors of the sac and active nasal disease,[70] and in the elderly.[69]

---

61. Masini, C.: A Case of Tuberculosis of the Lacrimal Gland, Osp. maggiore, Milano **36**:341-346 (July) 1948.

62. Mildenberger: Inflammation of the Lacrimal Gland in Dysentery (Rheumatoid Dysentery), Klin. Monatsbl. f. Augenh. **113**:268-269 (March) 1948.

63. Heath, P.: Mikulicz's Disease and Syndrome, Am. J. Ophth. **31**:955-964 (Aug.) 1948.

64. Vrabec, F.: Retention Cyst of the Orbital Part of the Lacrimal Gland, Československ. ofth. **4**:350-356, 1948.

65. Charamis, J.: Adenocarcinoma of the Lacrimal Gland, Bull. Greek Ophth. Soc. **14**:67-69 (Jan.) 1947.

66. Rubin, I. E.: Mixed-Cell Tumor of Lacrimal Gland, Am. J. Ophth. **31**:1318-1319 (Oct.) 1948.

67. Cosmettatos, G.: Carcinoma of the Lacrimal Gland, Bull. Greek Ophth. Soc. **14**:56-57 (Jan.) 1947.

68. Grom, E.: Epithelioma of the Lacrimal Gland, Arch. d'opht. **8**:593-610 (June) 1948.

69. MacMillan, J. A.: Diseases of the Lacrimal Gland and Ocular Complications, J. A. M. A. **138**:801-805 (Nov. 13) 1948.

70. Hogan, M. J.: Dacryocystorhinostomy, Tr. Am. Acad. Ophth. **52**:600-612 (July-Aug.) 1948.

The choice of surgical technic varies. Hogan [70] reports cures in 90 per cent of 49 cases, and Jones [71] six failures in 167 cases, with the Toti-Mosher technic. Réthi [72] also advocates this technic; however, Nie [73] and Corrado [74] prefer the procedure of Dupuy-Dutemps and Bourget, while Liebermann [75] performs the endonasal operation. Shuttleworth [76] prefers the external approach but obtained good results in 60 cases whether the nasal and lacrimal membranes were sutured or not. Garcia [77] prefers a continuous mucomucosal suture. Englebrecht [78] sutures the anterior flap to the periosteum of the bridge of the nose, and Cantullera [79] fixes the anterior flap firmly to the skin, while Medvedev [80] applies sutures to the nasal mucosa before incising it over a probe introduced into the middle meatus. However, most ophthalmologists prefer the external approach, and all are agreed that a large rhinostomy is essential.

Moreu [81] has used fibrin foam to control hemorrhage arising during dacryocystorhinostomy and to prevent severe late hemorrhage.

Linhares [82] thinks his successes have been increased because he passes an endless silk thread through the lower canaliculus and lacrimal sac.

Grignolo [83] reports the reconstruction of the lacrimal sac with conjunctiva taken from a cadaver.

CONJUNCTIVA

Acute Conjunctivitis.—A girl aged 7 months with acute purulent conjunctivitis due to type 2 Meningococcus (Neisseria meningitidis) was considered to have been infected from an uncle who had the organisms in his nasopharynx (Lewis and Ferris [84]).

---

71. Jones, A. C.: Toti-Mosher Operation for Cure of Dacryocystitis, Northwest Med. **48**:110-111 (Feb.) 1949.

72. Réthi, A. I.: Surgery of the Lacrimal Sac, Szemeszeti Tanulmanyok, 1948, pp. 13-20.

73. Nie, T. H.: On Operations of the Lacrimal Sac, Nat. M. J. China **34**:7-12, 1948.

74. Corrado, M.: Contribution to Surgical Treatment of Epiphora Due to Obstruction of the Lacrimal Passages, Ann. ottal. e clin. ocul. **74**:65-99 (Feb.) 1948.

75. Liebermann, T.: Modern Ideas on the Surgical Treatment of a Lacrimal Sac, Orvosok lapja **4**:1385-1387, 1948.

76. Shuttleworth, F. N.: An Advocacy of External Dacryocystorhinostomy, Brit. J. Ophth. **33**:183-187 (March) 1949.

77. Garcia, J. A.: Rapid Dacryocystorhinostomy with Continuous Mucomucosal Suture, Arch. Soc. oftal. hispano-am. **8**:1037-1045 (Oct.) 1948.

78. Engelbrecht, K.: Technic of Dacryocystorhinostomy, Klin. Monatsbl. f. Augenh. **113**:268 (March) 1948.

79. Cantullera, J. A.: Dacryocystorhinostomy, Arch. Soc. oftal. hispano-am. **8**:1031-1036 (Oct.) 1948.

80. Medvedev, N. I.: Suture Technic in Dacryocystorhinostomy, Vestnik oftal. **24**:41-42 (June) 1947.

81. Moreu, A.: Recent Advances in Hemostasis: Its Application to the Technic of Dacryocystorhinostomy, Arch. Soc. oftal. hispano-am. **8**:1024-1030 (Oct.) 1948.

82 Linhares, F.: Plastic Dacryocystorhinostomy, Rev. brasil. de cir. **17**:81-88 (Feb.) 1948.

83. Grignolo, A.: Contribution to Surgery of the Lacrimal Passages: Autoplasty of the Lacrimal Sac and Reconstruction by Grafting of Conjunctival Mucous Membrane from a Cadaver, Minerva chir. **3**:222-225 (June) 1948.

84. Lewis, N., and Ferris, A. A.: A Case of Primary Meningococcal Conjunctivitis, M. J. Australia **1**:621-622 (May) 1948.

Sadoughi [85] found an acute mucopurulent conjunctivitis with inflammation of the preauricular lymph nodes to be due to the colon bacillus (Escherichia coli).[85]

From a study of the bacterial flora of the conjunctiva of chickenpox and measles, Trovati [86] concludes that the conjunctival lesions are due to the virus of the disease but that the lesions may be made worse by secondary bacterial infection. In cases of scarlet fever he found streptococci and staphylococci only.

Hartmann and Auvert [87] report that sulfonamide therapy was more effective than penicillin therapy in a case of acute infectious conjunctivitis (caused by the Koch-Week's bacillus).

Lepri [88] was unable to produce conjunctivitis by instillation of Proteus morganii on the conjunctiva of animals but found that the organism caused severe inflammation after subconjunctival or intracorneal injection or inoculation of the anterior chamber.

Treatment of Gonococcic Conjunctivitis.—Comparative studies of results of sulfonamide and penicillin therapy with older methods of treatment show gratifying improvement. The rates for both complications and morbidity have diminished with sulfonamide therapy and have decreased further with penicillin treatment.[89] According to Denes,[90] the average period of hospitalization with older methods in Budapest was 26 days, as compared with 14 days for sulfonamide therapy and four days for penicillin treatment. McEvoy [91] reports similar morbidity rates from Philadelphia, i. e., 18, 9 and 6 days.

The incidence of corneal ulceration is lower with sulfonamide therapy, and even lower with penicillin therapy, than with older methods of treatment. However, once corneal ulceration has developed during less effective methods of treatment, scarring and loss of vision invariably result, even though sulfonamides and penicillin are used.[92]

Owing to the increasing resistance of gonococci to sulfonamides, genital gonorrhea was cured by sulfonamide therapy alone in only 44 per cent of cases or less in Germany in 1945-1946.[93] This indicates the need of combined therapy,[94] and Bruens warns of the danger of a similar resistance developing to penicillin.

---

85. Sadoughi, G.: Acute Mucopurulent Conjunctivitis Due to the Colon Bacillus, Bull. Soc. d'opht. de Paris **2**:65-67 (Feb.) 1948.

86. Trovati, E.: Conjunctival Bacterial Flora in Some Exanthematous Diseases of Infancy, Ann. ottal. e clin. ocul. **74**:358-368 (May) 1948.

87. Hartmann, E., and Auvert, B.: Two Recent Cases of Week's Bacillary Conjunctivitis, Bull. Soc. d'opht. de Paris, Dec. 1948, pp. 747-748.

88. Lepri, G.: Serious Corneal Infection Due to a Variety of Proteus (P. Morganii): Bacteriological and Experimental Research Work, Arch. ottal. **52**:231-254 (Sept.-Oct.) 1948.

89. Redl, T.: Treatment of Gonococcic Conjunctivitis in the Newborn at the II University Eye Clinic in Vienna, Klin. Monatsbl. f. Augenh. **113**:353-362 (April) 1948.

90. Denes, Z.: Penicillin Treatment of Gonococcic Ophthalmia, Szemeszeti tanulmanyok, 1948, pp. 135-137.

91. McEvoy, J. P.: Ophthalmia Neonatorum and Gonococcal Conjunctivitis, Eye, Ear, Nose & Throat Monthly **28**:25-29 (Jan.) 1949.

92. Euler, P.: Penicillin Treatment of the Eye, Klin. Monatsbl. f. Augenh. **113**:65-66 (Jan.) 1948.

93. Bruens, E.: Treatment of Gonococcic Blennorrhea with Chemotherapeutic and Antibiotic Agents, Klin. Monatsbl. f. Augenh. **112**:327-332 (April) 1947.

94. Bruens, E.: Visible Effects of Concentrated Sulfonamides on the Eye of the Newborn with Gonococcic Blennorrhea, Klin. Monatsbl. f. Augenh. **112**:251-255 (March) 1947. Nashid, E.: Chemotherapy of Acute Ophthalmia, Bull. Ophth. Soc. Egypt **35**:153-154, 1942.

Prophylaxis of Gonococcic Conjunctivitis of the Newborn.—Substitution of penicillin drops or ointment for the Credé method of prophylaxis is being tried widely. Fadda and Azmbetti [95] advocate the use of ointment, containing 500 units of penicillin per gram, immediately after birth and then twice daily for five days. With this technic they report an incidence of 0.29 per cent of gonococcic conjunctivitis (gonorrheal ophthalmia), as compared with a previous incidence of 1.2 to 2.1 per cent. These data would suggest poor technic of administration of either drug, since the incidence of gonococcic conjunctivitis has been shown to be less than 0.2 per cent when the method of Credé was properly employed. Halbron and associates [96] report one case of gonococcic conjunctivitis in 2,000 infants after penicillin prophylaxis but do not mention the incidence for silver nitrate prophylaxis. Labignette [97] mentions the increased expense of penicillin prophylaxis.

Parinaud's Oculoglandular Syndrome.—Parinaud's conjunctivitis is a syndrome with a definite clinical picture [98] but with a variety of causative agents, i. e., Leptothrix, Mycobacterium tuberculosis, Pasteurella tularensis and virus. Therefore it is better to make a specific diagnosis [99] in a given case and to reserve the group name for didactic purposes.

An unusual case of leptotrichosis of the conjunctiva was observed by Kant.[100] Although it was typical in other respects, there was hemorrhage in the conjunctival nodule with spontaneous suppuration and drainage of the preauricular lymph node.

Hartmann [99] believes that most cases of Parinaud's conjunctivitis are due to bovine tuberculosis and recommends electrocoagulation twice a week with about 20 diathermy punctures each time and just enough current (80 to 150 milliamperes) to produce whitening in two to three seconds.

Mattos [101] gives the incidence of primary tuberculosis of the conjunctiva as 1 case in 60,000, and the average age as 20 years. However, Bardy [98] observed a case of primary human tuberculosis in an 8 year old boy, and Stammbach,[102] in a 7 year old boy. Ravn Sørensen's [103] patient was a 24 year old woman.

Although Bardy's patient received no benefit from 4 Gm. of streptomycin, García Miranda [104] reports both subjective and objective improvement in a case

95. Fadda, A., and Azmbetti, E.: Prophylaxis of Gonococcic Ophthalmia Neonatorum with Penicillin Ointment, Rassegna ital. d'ottal. **17**:207-217 (May-June) 1948.

96. Halbron, P.; Lepage, F.; Lecomte, C., and Mawas, H.: Trial Prophylaxis of Ophthalmia Neonatorum with Penicillin, Ann. d'ocul. **181**:676-680 (Nov.) 1948.

97. Labignette, P.: Prevention of Purulent Ophthalmia, Concours méd. **70**:2546, 1948.

98. Bardy, K. I.: Oculoglandular Syndrome of Parinaud, Szemeszeti tanulmanyok, 1948, pp. 151-156.

99. Hartmann, K.: Ectogenous Conjunctival Tuberculosis Due to Bovine Tubercle Bacilli: Treatment by Electrocoagulation; Contribution to Parinaud's Symptom Complex, Klin. Monatsbl. f. Augenh. **113**:20-28 (Jan.) 1948.

100. Kant, A.: An Unusual Case of Leptothricosis Conjunctivae, Am. J. Ophth. **31**:607-608 (May) 1948.

101. Mattos, B. R.: Primary Complex of the Conjunctiva, Arq. brasil. de oftal. **11**:7-9 (Jan.) 1948.

102. Stammbach, H.: Primary Tuberculosis of the Conjunctiva, Helvet. pædiat. acta **4**:92-95 (Jan.) 1949.

103. Ravn Sørensen, C. H.: A Case of Primary Conjunctival Tuberculosis, Acta ophth. **27**:113-118 (Jan.) 1949.

104. García Miranda, R.: Case of Conjunctival Tuberculosis Treated with Streptomycin, Arch. Soc. oftal. hispano-am. **8**:747-752 (July) 1948.

of secondary conjunctival tuberculosis treated by conjunctival instillations combined with subconjunctival injections of streptomycin.

Virus Infections.—Molluscum Contagiosum: When nodules of molluscum contagiosum involve the lid margin, conjunctivitis frequently develops. It usually resembles Béal's follicular conjunctivitis and often is accompanied with superficial keratitis. Wolfe and Wolfe [105] observed a case of unilateral conjunctivitis in a white girl aged 17; the condition persisted in spite of penicillin and sulfathiazole therapy until a molluscum nodule was removed from the lid margin.

Vaccinia.—Vaccinia of the eye is more frequent and more serious than is usually stated, according to Potocek.[106] During 1947 and 1948 he treated this condition in eight cases. In only two was it due to autoinoculation. In three children membranous conjunctivitis developed, and in two of these a disciform type of keratitis appeared eight days after onset of symptoms. During the same period 23 other cases of ocular vaccinia were treated in 17 eye departments in Moravia.

Virus of Newcastle Disease.—Two cases of acute conjunctivitis associated with disease of the preauricular lymph nodes were proved by Freymann and Bang [107] to be due to the virus which causes Newcastle disease in fowls. The incubation period probably was less than 24 hours, and the disease cleared slowly after five days.

Epidemic Keratoconjunctivitis.—Epidemic keratoconjunctivitis first appeared in Germany in 1938, when it spread all over the country. In Berlin [108] the epidemic began the last few weeks in July, reached its climax in September and subsided during the winter months, but broke out again in the spring and summer of 1939. Outbreaks [109] occurred throughout Germany [110] again in 1941-1942 and in 1944. The incubation period, clinical manifestations, cause and complications were similar to those reported in this country and were identical with reports of the disease from France,[111] Batavia [112] and Italy.[113]

---

105. Wolfe, O. D., and Wolfe, R. M.: Molluscum Contagiosum and Conjunctivitis: Case Report, Eye, Ear, Nose & Throat Monthly **38**:129-130 (March) 1949.

106. Potocek, O.: Vaccinia of the Eye, Československ. ofth. **5**:4-8 (Jan.) 1949.

107. Freymann, M. W., and Bang, F. B.: Human Conjunctivitis Due to Newcastle Virus in the U. S. A., Bull. Johns Hopkins Hosp. **84**:409-413 (May) 1949.

108. Ohm, W.: Is Epidemic Keratoconjunctivitis Really Contagious? Med. Klin. **44**:212-213 (Feb. 18) 1949.

109. von Wolffersdorff, H.: Comparative Observations on Course and Therapy as Well as Epidemiology of 2 Epidemics of Epidemic Keratoconjunctivitis in Glauchau, Saxony During 1938, Klin. Monatsbl. f. Augenh. **113**:36-43 (Jan.) 1948.

110. Bunge, E.: Epidemic of Superficial Punctate Keratoconjunctivitis in 1944 in Lower Silesia and Its Correlations with Various Aspects of the Epidemic Keratoconjunctivitis in 1938, Klin. Monatsbl. f. Augenh. **113**:369-376 (April) 1948.

111. Hartmann, E.: Outbreak of Epidemic Keratoconjunctivitis in the Paris Area, Bull. Soc. d'opht. de France, Feb. 1949, pp. 329-336. Dubar, J., and Vidal, R.: Epidemic of Keratoconjunctivitis in Billancourt, ibid. Feb. 1949, pp. 342-345.

112. Sie-Boen-Lian: Epidemic Keratoconjunctivitis in Batavia, 1946-1947: A Clinical Study, Ophthalmologica **116**:86-100, (Aug.) 1948.

113. Busacca, A.: Epidemic Conjunctivitis and Punctate Keratitis: Clinical and Bacteriological Study of 9 Cases, Ann. ottal. e clin. ocul. **74**:119-127 (Feb.) 1948.

Trachoma.—The rickettsial theory of the cause of trachoma is discarded by Bietti [114] because the causative agent will not grow in the intestine of the louse or on the chorioallantoic membrane, because the Weil-Felix reaction is negative in countries where typhus is not endemic and because paraaminobenzoic acid [115] has no effect on the elementary bodies. Nataf [116] believes that the causative agent is a corpuscular parasite conforming in some respects to organisms of the Rickettsia family but differing in others. Poleff [117] thinks that the agent of trachoma requires a place between rickettsias and viruses. However, Taborisky [118] confirms his previous stand that the Prowazek-Halberstaedter bodies are the cause of trachoma and are similar to the viruses of psittacosis and lymphogranuloma venereum.

Blanc, Pages and Martin [119] found that in monkeys previously inoculated with murine and epidemic typhus, with Rocky Mountain spotted fever and with boutonneuse fever typical trachoma developed.

Pages [120] concludes from his studies that there is a life cycle of the causative agent of trachoma. This confirms a similar observation made by Thygeson several years ago.

Bodian [121] found that the use of a Wratten E,* series 23 A light red photographic filter anywhere in the optical system between the light source and the eyepiece was of great help in finding inclusion bodies in scrapings stained by the Giemsa technic. The cytoplasm of the epithelial cells appeared pale gray, the nuclei medium gray and the inclusion bodies intensely black. Brand [122] reports that the application of a 1 per cent solution of toluidine blue to the alcohol-fixed specimen, for 90 seconds, followed by washing, permits the rapid location of inclusion bodies. Nuclei of epithelial cells stain blue; cytoplasm stains very light blue, and inclusion bodies stain dark blue, with a definite morula structure. Eareckson [123] reports two cases in order to revive the use of Wright's stain instead of the Giemsa stain as a time-saving device.

---

114. Bietti, G.: The Ultraviruses in Ocular Pathology, Boll. d'ocul. **27**:1-19 (Jan.) 1948.

115. Bietti, G. B., and Pasca, G.: Inefficacy of *P*-Aminobenzoic Acid in the Therapy of Trachoma: Its Value in Relation to the Rickettsial Nature of Trachoma, Boll. Soc. ital. biol. sper. **23**:861-863 (July) 1947.

116. Nataf, R.: Etiology of Trachoma, Arch. d'opht. **7**:589-598 (June) 1947; Rev. internat. trachoma **25**:50-70 (Jan.) 1948.

117. Poleff, L.: Introduction to Experimental Trachomatology, Docum. ophth. **2**:297-461, 1948.

118. Taborisky, J.: Discovery of the Trachoma Agent, Acta med. orient. **7**:61-71 (April) 1948.

119. Blanc, G.; Pages, R., and Martin, L.: Two Years of Research on Trachoma of Monkeys at the Pasteur Institute of Casablanca, Rev. internat. trachome **25**:172 (March) 1948.

120. Pages, R.: Note on the Life Cycle of the Causative Agent of Trachoma, Maroc méd. **27**:494-498, 1948.

121. Bodian, M.: An Aid in Detecting Trachoma-Like Inclusion Bodies in the Conjunctiva, Arch. Ophth. **40**:147-151 (Aug.) 1948.

122. Brand, E.: A New Rapid Method for Demonstration of Inclusion Bodies in Trachoma, Ophthalmologica **116**:61-63 (July) 1948; A New Rapid Technic for Demonstrating Inclusion Bodies and Corpuscles of Trachoma, Maroc méd. **27**:499-501, 1948; A New Rapid Staining Technic for Trachomatous Inclusion Bodies, Orvosi hetil. **89**:405-406, 1948.

123. Eareckson, V. O., Jr.: Demonstration of Trachoma Inclusion: A Practical and Rapid Staining Technique, Am. J. Ophth. **32**:702-703 (May) 1949.

Mirenburg [124] reports the virtual disappearance of trachoma in Jewish school children, whereas approximately 40 per cent of the Arab children attending government schools and approximately 99 per cent of children in countries surrounding Jerusalem still have the disease. He attributes this to the 30 year antitrachoma campaign of the Hadassah Medical Organization. Rabadan [125] and Sztrilich [126] emphasize Mirenburg's point that it is not sufficient to treat the children but that the service must be extended to include the entire family, if the disease is to be eradicated.

Sulfonamides remain the treatment of choice in trachoma (Liu,[127] Trowbridge,[128] Rabadan [129] and Pasca [130]). Penicillin has little effect (Jébéjian [131]) and streptomycin even less (Bietti and Pasca,[132] Focosi and Scalfi [133]). Taliercio and Zeppa [134] report that instillation of a 25 per cent solution of benzoquinoxonal (BQX; dibenzenaminoxysuccinate sodium) twice a day has a favorable influence on the disease.

Fungous Infections.—The sixth case of rhinosporidiosis of the conjunctival sac reported in North America was observed in a 12 year old white boy by Edmunds and Beck.[135] A small granulomatous tumor removed from the left lower lid revealed numerous round, thick-rimmed, double-contoured sporangia of Rhinosporidium seeberi. Excision of the tumor and cauterization of the base constitute the best treatment at present.

A case of membranous conjunctivitis reported by Sobhy Bey and Attiah [136] probably was due to infection with Streptothrix and Staphylococcus aureus.

Sjögren's Syndrome.—A case of acute parotitis associated with dryness of the eyes and mouth was observed by Allenic.[137] Dryness of the mucous membranes

124. Mirenburg, B.: The Antitrachoma Campaign in Jewish Schools of Jerusalem, Am. J. Ophth. **31**:1289-1292 (Oct.) 1948.

125. Rabadan, F. P.: Trachoma as a Social Problem in Spain: Critical Essay, Acta clin. July-Aug.-Sept. 1948, pp. 208-226.

126. Sztrilich, L.: Organization and Development of the Struggle Against Trachoma at the Trachoma Dispensary at Bonyhad, Népegészségügy **29**:636-640, 1948.

127. Liu, I. S.: The Diagnosis and Treatment of Trachoma, Nat. M. J. China **34**:37-43, 1948.

128. Trowbridge, D. H.: Trachoma: A Clinical Review, Eye, Ear, Nose & Throat Monthly **27**:357-362 (Aug.) 1948.

129. Rabadan, F. P.: Treatment of Trachoma, Acta clin., January, 1948, pp. 33-72.

130. Pasca, G.: Effects of Sulfonamide Therapy in Trachoma: Statistical Study, Boll. d'ocul. **27**:383-389 (June) 1948.

131. Jébéjian, R.: The Effect of Local Penicillin Therapy on Trachoma; 17 Cases, Ann. d'ocul. **181**:359-363 (June) 1948.

132. Bietti, G. B., and Pasca, B.: Activity of Streptomycin on the Halberstaedter-Prowazek Bodies in Trachoma, Boll. Soc. ital. biol. sper. **24**:82-85 (Jan.-Feb.) 1948.

133. Focosi, M., and Scalfi, L.: Association of Streptomycin and Sulfonamide in Trachoma: First Attempts, Boll. Soc. ital. biol. sper. **23**:701-703 (July) 1947.

134. Taliercio, A., and Zeppa, R.: BQX in Treatment of Trachoma (First Communication), Rassegna internaz. clin. e terap. **28**:561-563 (Dec.) 1948.

135. Edmunds, M., and Beck, R.: Rhinosporidiosis of the Conjunctiva: Case Report, Virginia M. Monthly **75**:278-280 (June) 1948.

136. Sobhy Bey, M., and Attiah, M. A. H.: A Case of Membranous Conjunctivitis Possibly Due to Fungous Infection, Bull. Ophth. Soc. Egypt **35**:103-108, 1942.

137. Allenic: A Serious Case of Dry Conjunctiva (Sjögren's Syndrome), Ann. d'ocul. **180**:706-707 (Nov.) 1947.

persisted, however, after the parotitis had subsided. Ellman and Weber [138] observed a patient with dryness of the bronchial mucosa in addition to the usual signs.

Most recent authors [139] believe that the disease is due to a derangement of the endocrine [140] and/or sympathetic systems. For this reason, Allenic tried pilocarpine in his case, but the drug was tolerated poorly.

Erythema Multiforme Exudativum.—This syndrome, originally defined by Hebra in 1866, is now described under many diagnoses, some of which are ectodermosis erosiva pluriorificialis of Fiessinger and Rendu, eruptive fever with stomatitis and ophthalmia, Johnson-Stevens syndrome, Baader's dermatostomatitis, Behcet's triple syndrome, erythema bullosum malignans, pluriorificial type, and aphthous oral and genital ulcers with conjunctivitis.

Two types of the disease are distinguished by Löffler, Martin and Babel [141]: (1) a mild type, with erythematopapular lesions, and (2) a more serious type, with vesicobullous lesions of the skin; but the two types may occur together.

Children (Böhringer [142]) and young men (Widerman,[143] Monteiro,[144] Soll,[145] Wolff,[146] Nelson and Burtness,[147] O'Donnell [148]) are most susceptible, the majority of the cases occurring in the spring and autumn (Costello [149]).

The onset is acute, and usually the first lesions involve the mucous membrane of the eyes, nose, mouth, genitalia and perianal area. Chills and fever (Ström [150]) ensue, followed by prostration. Papular, macular or bullous cutaneous lesions may appear. Sometimes the bullae may be generalized, and there may be exfoliation of the nails and diffuse falling of the hair. The outcome is occasionally

138. Ellman, P., and Weber, F. P.: Sjögren's Disease, with Dryness of the Bronchial Mucosa and Uncertain Lung Lesion, Brit. M. J. **1**:304-305 (Feb. 19) 1949.

139. Roussel, F.: Keratoconjunctivitis Sicca, Bull. Soc. belge d'opht. **89**:394-401, 1948.

140. Belz: Ophthalmological Considerations on the Syndrome of Sjögren, Ann. odontostomatol. **5**:439-462 (Dec.) 1948.

141. Löffler, H.; Martin, E., and Babel, J.: Symptomatology of Erythema Exudativum Multiforme, Helvet. med. acta **14**:526-528 (Sept.) 1947.

142. Böhringer, H. R.: Stevens-Johnson Disease and the Eye, Praxis **37**:930-932 (Dec. 16) 1948.

143. Widerman, A.: Eruptive Fever with Stomatitis and Ophthalmia (Stevens-Johnson), Ann. Int. Med. **27**:830-834 (Nov.) 1947.

144. Monteiro, M.: Oculo-Buccal-Genital Syndrome of Behcet, Bol. Soc. Portuguesa oftal. **5**:125-135, 1946-1947.

145. Soll, S. N.: Eruptive Fever with Involvement of the Respiratory Tract, Conjunctivitis, Stomatitis and Balanitis: An Acute Clinical Entity Probably of Infectious Origin; Report of 20 Cases and Review of the Literature, Arch. Int. Med. **79**:475-500 (May) 1947.

146. Wolff, J. E.: Ocular Complications in Erythema Exudativum Multiforme with Mucous Membrane Lesions (Pluriorificial Erosive Ectodermosis of Fiessinger and Rendu, Stevens-Johnson Disease, Baader's Dermostomatitis), Brit. J. Ophth. **33**:110-120 (Feb.) 1949.

147. Nelson, L. M., and Burtness, H. I.: Aphthous Oral and Genital Ulcers with Conjunctivitis (Behcet's Triple Symptom Complex), California Med. **69**:453-455 (Dec.) 1948.

148. O'Donnell, J. M.: Behcet's Triple Syndrome, M. J. Australia **1**:730-732 (June 14) 1947.

149. Costello, M. J.: Erythema Multiforme Exudativum (Erythema Bullosum Malignans—Pluriorificial Type): Personal Observations of Cases in Willard Parker Hospital for Contagious Diseases (1932-1946), J. Invest. Dermat. **8**:127-144 (March) 1947.

150. Ström, J.: Stevens-Johnson Syndrome (Ectodermosis Erosiva Pluriorificialis), Nord. med. **40**:1929-1934, 1948.

fatal (Costello,[147] Johnstone [151]); but if secondary infection is controlled a limited course or a favorable outcome may be expected. Complications may be conjunctival (Folk [152]) or corneal scarring, blindness (Costello,[149] Soll,[145] Shaffer and Morris [153]), stenosis of the vagina (Costello [149]) and bronchopneumonia (Soll [145]).

The disease may recur (Wright, Gold and Jennings [154]; Martin, Babel and Löffler [155]; Rosenberg.[156]

The cause of the disease is unknown, although in some cases allergy (Godtfredsen [157]) or drug sensitivity (Folk,[152] Shaffer and Morris [153]) seems to be responsible.

No specific treatment is effective, although antihistaminic drugs have seemed beneficial in some cases (Salomon,[158] Rosenberg [156]). Penicillin or sulfadiazine, although of no value for the disease (Johnstone [151]; Martin, Babel and Löffler [155]), may be useful in the treatment of secondary infections (Widerman [143]).

Phlyctenular Conjunctivitis and Keratoconjunctivitis.—Evidence continues to develop that phlyctenular disease may have many causes. Lo Cascio and Capolongo [159] describe phlyctenular-like keratoconjunctivitis in patients with smallpox, and Raski [160] reports 37 cases in patients with chronic infections of the upper respiratory tract whose reactions to tuberculin were negative. Hornych [161] reports on three cases of ovarian dysfunction in which recurrent phlyctenular keratoconjunctivitis resisted the usual treatment but responded to ovarian hormone extracts, and Stephenson [162] describes a case in which the disease was apparently due to staphylococcic infection.

---

151. Johnstone, D. F.: Fatal Case of Stevens-Johnson's Syndrome, Lancet **2**:276-277 (Aug. 23) 1947.

152. Folk, M. R.: Erythema Exudativum Multiforme, Am. J. Ophth. **31**:621-622 (May) 1948.

153. Shaffer, B., and Morris, P.: Severe Erythema Multiforme of the Pluriorificial Type (Stevens-Johnson Syndrome) Resulting in Blindness in Patient Treated with Trimethadione (Tridione), Pediatrics **2**:30-34 (July) 1948.

154. Wright, D. O.; Gold, E. M., and Jennings, G.: Stevens-Johnson Syndrome: Report of 9 Patients Treated with Sulfonamide Drugs or Penicillin, Arch. Int. Med. **79**:510-517 (May) 1947.

155. Martin, E.; Babel, and Löffler: Erythema Multiforme and Its Ocular Complications, Praxis **36**:186-187 (March 13) 1947.

156. Rosenberg, S. W.: Stevens-Johnson Syndrome: Report of a Case with 2 Major and 4 Minor Recurrences, Wisconsin M. J. **47**:766-768 (Aug.) 1948.

157. Godtfredsen, E.: Pathogenesis of Concurrent Eye and Joint Diseases, Brit. J. Ophth. **33**:261-270 (May) 1949.

158. Salomon, M. I.: Stevens-Johnson Syndrome Treated with Antihistaminic Drugs, New York State J. Med. **49**:198-199 (Jan. 15) 1949.

159. Lo Cascio, G., and Capolongo, G.: Ocular Complications of Smallpox: Etiologic Study, Gior. ital. oftal. **1**:119-131 (March-April) 1948.

160. Raski, K.: Keratoconjunctivitis Associated with Sinusitis, Duodecim **65**:115-121 (Feb.) 1949.

161. Hornych, J.: Relation Between the Genital Glands and Allergic Diseases of the Eye, Ceskoslov. ofth. **4**:226-227, 1948.

162. Stephenson, R. W.: Phlyctenular Kerato-Conjunctivitis Treated with Penicillin, Lancet **2**:144-145 (July 24) 1948.

Conjunctival Allergy.—Kamel [163] reports that the presence of eosinophils in a properly prepared conjunctival smear is a positive sign of vernal conjunctivitis and bears no relation to eosinophilia of the blood. This confirms a previous report by Sobhy Bey.

A case of allergic blepharoconjunctivitis following the application of diocaine® [164] is reported, and allergic conjunctivitis due to sensitivity to substances from the silkworm [165] is reported in a man aged 50.

Acne rosacea conjunctivitis may arise on an allergic basis. Walker [166] reported that 70 per cent of patients gave positive reactions to specific antigens and responded well to desensitization. The remaining patients in the series were treated by injections of histamine azoglobulin, but 43 per cent showed recurrences.

Among the methods of treatment reported to be beneficial, but not curative, in cases of allergic conjunctivitis are intramuscular injections of riboflavin,[167] vitamin D,[168] intramuscular autohemotherapy [169] and antihistaminics.[170] Irradiation of the thymus in the treatment of vernal conjunctivitis was unsuccessful, according to Rubino and Simonelli.[171]

Conjunctival Parasites.—Several conjunctival or subconjunctival parasites have been observed and removed recently. Chang [172] recovered a female Thelazia from the conjunctival sac of a 14 year old Japanese girl. D'Uby [173] extracted filarias from the subconjunctival tissues of three patients who had been infected in tropical Central Africa. Kamel [174] discovered larvae of Oestrus ovis in the conjunctival sac of a European woman in Egypt, but in Bulgaria Caralambov [175] removed 18 of

163. Kamel, A.: Is the Eosinophile Leucocyte Normally Present in Smears from Conjunctiva? Bull. Ophth. Soc. Egypt **35**:97-100, 1942.

164. Pajtas, J.: Allergic Blepharoconjunctivitis After Diocaine, Ophthalmologica **116**:144-148 (Sept.) 1948.

165. Tavolara, L.: Conjunctival Allergy in a Subject Suffering from Bronchial Asthma, Provoked by "Bombix Mori" and Its Derivatives, Med. d. lavoro **39**:225-228 (July) 1948.

166. Walker, V. B.: Allergic Conditions of the Eye: Keratitis Rosacea, Brit. J. Ophth. **32**:759-764 (Oct.) 1948.

167. Gutmann, J. M.: Allergic Warm Season Conjunctivitis (Conjunctivitis Vernalis, Spring Catarrh, Vernal Conjunctivitis), Acta med. orient. **6**:167-169 (May) 1947.

168. Nolasco, F.: Treatment of Phlyctenular Conjunctivitis by Super-Concentrated Vitamin D, Bol. Soc. Portuguesa oftal. **5**:113-116, 1946-1947.

169. Vassilipoulos, B.: Treatment of Vernal Conjunctivitis with Autohemotherapy, Bull. Greek Ophth. Soc. **14**:60-63 (Jan.) 1947.

170. Hurwitz, P.: Antistine in Ocular Allergy, Am. J. Ophth. **31**:1409-1421 (Nov.) 1948. Musini, A.: Use of Antihistaminics in Treatment of Allergic or Presumed Allergic Diseases of the External Eye, Osp. maggiore, Milano **36**:180-184 (April) 1948. Kadlecova, V.: Atypical Spring Catarrh, Českoslov. ofth. **4**:427-429, 1948. Klima, M.: Experiences with Antistin, ibid. **4**:216-225, 1948. Esente, I.: Ocular Allergoses, Riv. oftal. **2**:164-170 (March-April) 1947.

171. Rubino, A., and Simonelli, M.: Irradiation of Thymus in Treatment of Vernal Conjunctivitis, Gior. ital. oftal. **1**:453-455 (Sept.-Oct.) 1948.

172. Chang, C. C.: A Case of Thelazia Callipæda of the Conjunctiva, Nat. M. J. China **34**:45-46, 1948.

173. d'Uby, D.: Three Cases of Ocular Filariasis, Algérie méd. **50**:433-435 (May) 1947.

174. Kamel, A.: A Case of Ophthalmomyiasis Externa, Bull. Ophth. Soc. Egypt **35**:145-147, 1942.

175. Caralambov, N.: Cases of Ocular Myiasis in Bulgaria, Ann. méd. **40**:499-503 (June) 1948.

these larvae from the lower fornix of one patient, five from another and eight from a third. Van Hoorn [176] removed a leech from the conjunctiva, and Junior [177] reports that the larvae of Taenia solium may encyst in the subconjunctival tissues.

Chemical Injuries.—Kurz [178] warns of a new type of lime burn and presents four cases of this type. Farmers using whitewash in pressure sprays sometimes have the solution blown into their eyes under pressure. This is likely to occur in the course of cleaning the spray after it becomes blocked. Among the therapeutic measures the author advocates are the transplantation of buccal mucosa in cases with extensive necrosis, the instillation of priscol® (2-benzyl-2-imidazoline) to stimulate the local circulation and the liberal application of 40 per cent dextrose for dehydration of the corneal tissue.

A purely mechanical irritation of the conjunctiva followed the accidental instillation of DDT powder (containing 75 per cent dichlorodiphenyltrichloroethane) into the conjunctiva of a young soldier. Similar results were obtained experimentally in dogs by Theorides.[179]

Glees [180] reports that damage to the eyes from smoke consists chiefly of superficial inflammation of the conjunctiva and cornea. More serious lesions usually indicate an additional factor or factors.

Conjunctival Tumors.—Lipoma of the conjunctiva was described by Saebø [181] in members of three generations—a 22 year old woman, her mother and her maternal grandfather.

After having observed several cases of pinguecula sequestrans in Indonesia, Mulock Houwer [182] reports the first case from the Netherlands. The greater part of the pinguecula consisted of exposed fragments or deposits of hyalin surrounded by inflammatory cells.

Myxomatous degeneration with intensive proliferation occurring in a hemangioma simplex of the bulbar conjunctiva was found by Bakker [183] in a woman aged 35. The patient had noticed rapid growth of the tumor for six weeks before it was removed.

Bakker [184] was unable to find evidence of a nervous origin of nevi cells with silver-staining methods in four cases of nevi of the semilunar plica and in one case of tumor of the caruncle.

---

176. van Hoorn, J. Z.: An Unusual Conjunctival Foreign Body, Nederl. tijdschr. v. geneesk. **93**:3748, 1948.

177. Junior, L.: Ocular Cysticercosis, Am. J. Ophth. **32**:523-548 (April) 1949.

178. Kurz, O.: Ocular Lesion Caused by Lime Spray, Schweiz. med. Wchnschr. **78**:635-638 (July 3) 1948.

179. Theorides, E.: Artificial Conjunctivitis Caused by DDT, Bull. Greek Ophth. Soc. **14**:36-42 (Jan.) 1947.

180. Glees, M.: Clinical Pictures of Smoke Damage to the Eye, Klin. Monatsbl. f. Augenh. **113**:43-44 (Jan.) 1948.

181. Saebø, J.: Lipoma Conjunctivae in 3 Generations, Acta ophth. **26**:447-450 (April) 1948.

182. Mulock Houwer, A. W.: Pinguecula Sequestrans, Nederl. tijdschr. v. geneesk. **93**:1641, 1949.

183. Bakker, A.: A Myxo-Haemangioma Simplex of the Conjunctiva Bulbi, Brit. J. Ophth. **32**:485-488 (Aug.) 1948; Hemangioma Simplex of the Conjunctiva Bulbi, Nederl. tijdschr. v. geneesk. **93**:1640-1641 (May 19) 1949.

184. Bakker, A.: Nevus Pigmentosa of the Plica Semilunaris, Nevus Pigmentosus of the Caruncle, Nederl. tijdschr. v. geneesk. **93**:1640 (May 19) 1949.

A diagnosis of lymphoma of the conjunctiva was made in a man aged 58 by Svoboda [185] ten months before general manifestations of lymphatic leukemia developed.

Chang [186] found 20 cases of plasmoma of the conjunctiva and cornea, in 18 of which there was trachoma. Thus he believes there is a close relation between the two diseases; Altenberger,[187] however, concludes from his study that plasmoma has the histological structure of a neoplasm and considers extirpation the best method of treatment.

Dostal [188] removed an osteoma from the upper outer quadrant of the eyeball of a boy aged 14. None of the other tissues usually found in a dermoid were present.

185. Svoboda, J.: Lymphoma of the Conjunctiva, Českoslov. ofth. **4**:296-300, 1948.

186. Chang, C. E.: Plasmoma of the Conjunctiva and Cornea, Nat. M. J. China **34**:23-27, 1948.

187. Alterberger, S. F.: Plasmoma; Plasmocytoma; Plasmoblastoma Conjunctivae, Klin. Oczna **18**:94-107 (Jan.) 1948.

188. Dostal: Osteoma Eburneum Conjunctivae, Českoslov. ofth. **4**:300-302, 1948.

Correspondence

POSTOPERATIVE DIPLOPIA

To the Editor:—Intractable diplopia following operation on the extraocular muscles is discussed in a recent paper by George L. Tabor Jr. (Intractable Postoperative Diplopia, ARCH. OPHTH. **44:** 517 [Oct.] 1950). Tabor has carefully sifted the literature and reported on a case of his own. His interesting study calls for comments on this important subject, which has received relatively little attention in the literature.

One must define one's terms. Diplopia occurring immediately after operation, troublesome persistent diplopia and horror fusionis are not necessarily the same thing, although diplopia is common to all three.

More or less transient diplopia after operation for squint is much more frequent than one should conclude from the statistics quoted by Tabor. As Krewson mentioned in his discussion of Tabor's paper, many patients experience transient diplopia while persistent diplopia is relatively rare. Transient diplopia is, in fact, rather the rule and occurs also in children, as is shown by appropriate investigation.

Most patients with strabismus, especially with pronounced monocular strabismus, have developed the faculty of supression to a high degree. They soon lose the diplopia which follows the operation. For the diplopia to be persistent, special conditions have to be fulfilled. One such condition is an anomalous correspondence well adapted to the preoperative angle of squint, which remains unchanged after operation, leading to what is known as paradoxical diplopia. Cyclotropia, resulting from tampering with the oblique muscles, is a particularly severe obstacle to binocular vision, as well as to the development of suppression. A pronounced surgical over-effect is another well known cause of persistent diplopia, as is aniseikonia, which has been found to be the responsible agent in some cases. It has been pointed out correctly by the various authors cited by Tabor that these conditions may lead to persistent diplopia, but not any one of them is the responsible factor in all cases. Persistent postoperative diplopia is considerably more frequent than the troublesome postoperative diplopia which impresses itself so much on the mind of the ophthalmologist. Not all the patients who have persistent diplopia also complain of it. If one inquires of one's patients (particularly of those operated on in adult life), one will not infrequently receive the answer that they notice diplopia if they pay attention to it or observe an object closely.

It seems to me that it is necessary to differentiate between suppression, which is an active physiological process, and the ability to disregard a second image. The majority of patients actually suppress equally well before and after operation. Among those who do not suppress eventually, for one of the reasons given above, one group is able to disregard the diplopia; another is not.

It is at this point that one has to consider the psychogenic factor, which has been emphasized by Tabor and, according to Tabor, also by Krimsky. Sensitive patients, patients inclined to be neurotic, may suffer considerably from their inability to disregard the diplopia. Tabor's case is a good example showing how this inability, or unwillingness, may be due to a psychogenic factor.

It would appear, however, that this case is not a good example of horror fusionis, as Tabor seems to think. In horror fusionis the diplopia—major as it is for the patient—is not the essential point of the clinical picture. In the ordinary cases of postoperative diplopia arising from one of the causes mentioned previously, it is often possible to make the patients see single under appropriate experimental conditions (for example, by correcting the cyclotropia on the major amblyoscope, or the like), although they may never lose the diplopia in casual seeing. But these patients

do not necessarily reject bifoveal stimulations; their diplopia is, so to speak, passive. In horror fusionis bifoveal stimulations are actively avoided; the small changes in the angle of squint on attempted bifoveal stimulation are the essence of the phenomenon. Patients with horror fusionis, admittedly a rare occurrence, in my experience always have normal correspondence; there is simply no attempt at any kind of binocular cooperation, not even anomalous. These patients never respond with fusion or stereopsis, no matter with what experimental situation they are presented.

In Tabor's patient fusion with considerable amplitudes and stereopsis could readily be obtained before and after operation. This excludes him automatically from the group of patients with horror fusionis. One cannot escape the impression that the patient should have been able to achieve binocular vision in casual seeing, with some good will on his part and assisted by competent orthoptic treatment. Psychotherapy might also have been helpful in this case.

The patients with postoperative diplopia present a real problem. To clarify it more reports such as the one presented by Tabor are needed. The classification suggested here and the suggested differentiation between suppression and the ability to disregard diplopia may be of assistance.

HERMANN M. BURIAN, M.D., Boston.

520 Commonwealth Avenue.

THE CROSSED CYLINDER TEST

To the Editor:—Dr. David I. Mirow's request (Cross Cylinder Test, ARCH. OPHTH. **43:** 1088 [June] 1950) for better teaching of the crossed cylinder test is long overdue. The test for axis is immeasurably superior to all others; and the test for strength is almost equally good when certain safeguards are borne in mind. I would refer Dr. Mirow to an article by his fellow countryman, Dr. W. H. Crisp, of Denver, Colo. (*Tr. Ophth. Soc. U. Kingdom* **51:** 495, 1932; *Am. J. Ophth.* **15:** 729 [Aug.] 1932).

In the same journal (*Tr. Ophth. Soc. U. Kingdom* **59:** 139, 1949) I drew attention to this excellent description of the crossed cylinder. For the life of me, I cannot understand why people do not use crossed cylinders in subjective refraction work (especially in the finding of the axis), for it can be shown that a crossed cylinder makes it six times less difficult for the patient to appreciate errors in axis position.

VICTOR PURVIS, M.B., D.O., Oxford, England.

News and Notes

EDITED BY DR. W. L. BENEDICT

GENERAL NEWS

American Board of Ophthalmology.—Candidates for the certificate of the American Board of Ophthalmology are accepted for examination on the evidence of a written qualifying test. These tests are held annually, in January, in various parts of the United States. Applications are now being accepted for the 1952 written test. Applications for this test must be filed before July 1, 1951.

Ninety-eight examinations have been held to date; the total number of certificates issued is 3,143; 273 applications were received during the fiscal year ending April 30, 1950. The results for 1950 follow.

WRITTEN QUALIFYING TEST 1950

	Passed	*Conditioned*	*Failed*	*Total*
January 13-14	151	144	44	339
EXAMINATIONS 1950				
Boston, May 22-26	98	49	2	149
Chicago, October 2-7	107	39	9	155

Practical examinations in 1951 are scheduled as follows:

San Francisco, March 11-16
New York, May 31-June 5
Chicago, October 8-13

Fifty-two ophthalmologists have served on the Board since its organization in 1917.

The personnel of the board for 1950 is as follows:

Term Ends	*Section of Ophthalmology, A. M. A.*	*American Ophthalmological Society*	*Academy*
Dec. 31, 1951	Thygeson	Post	Cordes
Dec. 31, 1952	Payne	Atkinson	Masters
Dec. 31, 1953	Dunnington	Adler	Vail
Dec. 31. 1954	Allen, Jas. H.	Dunphy	Fralick

OFFICERS FOR 1951

Chairman	John H. Dunnington, New York
Vice chairman	Derrick Vail, Chicago
Secretary-treasurer	Edwin B. Dunphy, Boston

Communications may be addressed to Executive Office, Cape Cottage, Maine.

Exhibit on Ophthalmoscope to Honor Helmholtz at the Medical Museum of the Armed Forces Institute of Pathology.—An exhibit honoring Hermann von Helmholtz, the inventor of the ophthalmoscope, will be displayed under the auspices of the Medical Museum of the Armed Forces Institute of Pathology and the Army Medical Library in the Medical Museum at Ninth and Independence Avenue, S. W., Washington, D. C., for six months, beginning Dec. 17, 1950.

This date marks the one-hundredth anniversary of Helmholtz' letter to his father describing the instrument which was to enable doctors to see the interior of the human eye for the first time.

The Museum's extensive and comprehensive collection of ophthalmoscopes, illustrating the development from the Helmholtz drawings to the modern electrified instrument, will be on display. Included will be the famous Dr. von Graefe's first instrument, made by Sydow from the original drawing and given to the Medical Museum by Dr. Harry Friedenwald just before his death in the spring of 1950.

A rare Perrin three dimensional ophthalmologic atlas will also be on display. It was designed and manufactured about 1870 and extensively used in that early period to train students in ophthalmology. Only three of these instruments are known to exist in this country.

The Army Medical Library has loaned many of the books to be shown. Included are many rare volumes, some of them found in the United States only at the Army Medical Library. Especially noteworthy in this respect are a Russian and two Japanese atlases of ophthalmoscopy, as well as the first printed illustration of the fundus of the eye, prepared by A. C. van Trigt for use in his doctoral dissertation soon after Helmholtz' report was made known, and the only published atlas of stereoscopic paintings of the fundus. A large number of contemporary American and foreign atlases will also be displayed.

Delta Gamma Fraternity Scholarship Funds for Training of Workers in Field of Sight Conservation and Aid to the Blind.—The Delta Gamma Fraternity has a $1,500 annual fund and a $2,000 revolving loan fund from which smaller scholarship awards are available to persons intending to become (1) orthoptic technicians, (2) teachers of partially seeing children or (3) specialists for blind preschool children. Any one wishing to specialize in one of these fields may be eligible for assistance, the amount in each case to be determined by the particular need and costs involved.

Candidates wishing to enroll for training in classification 1 should apply to Mrs. H. V. Draheim, 19641 Coral Gables, Birmingham, Mich.; those for training in classification 2 or 3, to Mrs. Thomas Johnson, 1235 Longfellow, Detroit 2.

Applications for scholarships should be filed four months prior to the start of the desired course. Persons with basic preparation in teaching, nursing, social work, nursery education or related fields are eligible to apply. The scholarships are intended only for the courses directly relating to the field of sight conservation and aid to the blind.

Candidates are selected with the advice of a professional committee: LeGrand H. Hardy, M. D., of the American Orthoptic Council, chairman; Mrs. Virginia Smith Boyce, assistant director, National Society for the Prevention of Blindness; Miss Ruth E. Lewis, professor of social work, George Warren Brown School of Social Work, Washington University; Dr. Berthold Lowenfeld, superintendent of the California School for the Blind; Miss Ruth B. McCoy, assistant director, New York State Commission for the Blind, and Lillian Ray Titcomb, M.D., president of the executive committee, Nursery School for the Visually Handicapped Children of Los Angeles.

American Orthoptic Council.—The American Orthoptic Council will present its fourth annual intensive course in orthoptics in Boston from July 5, 1951 through Aug. 31, 1951. Tuition is $150. The course is designed to present the basic didactic instruction, together with some practical instruction, necessary to prepare the student to complete a course of practical training and experience offered at various orthoptic centers over the country. The Council will make an effort to see that all students enrolled in the course have places to complete their practical training. Applicants must be at least 18 years of age, have had a high school education and be sponsored by an ophthalmologist. A few scholarships

are available to students from the Delta Gamma Fraternity Project. Inquiries and applications should be addressed to the American Orthoptic Council, Dr. Richard G. Scobee, 640 South Kingshighway, St. Louis 10.

SOCIETY NEWS

Association for Research in Ophthalmology, Inc.—The third annual meeting of the Midwest Section of the Association for Research in Ophthalmology, Inc., will be held at the University Hospitals, Iowa City, on Monday, March 19, 1951. The program will consist of the presentation of scientific papers.

On the two days following the meeting, a symposium on "External Diseases of the Eye" will be presented by the department of ophthalmology, State University of Iowa College of Medicine.

UNIVERSITY NEWS

Course in Orthoptic Technology.—The Washington University School of Medicine announces a full time course in orthoptic technology to be given annually. The next course begins Sept. 17, 1951 and extends to June 15, 1952. Both didactic and practical training are given in orthoptic technology, and a certificate is granted on successful completion of the course. Tuition is $350. Facilities for instruction include the Motility Clinic of the Washington University Clinics and the St. Louis Ophthalmic Laboratory, the latter under the direction of Miss Anita Stelzer. The course is limited to eight students. Applicants must be at least 18 years of age and high school graduates, preferably with at least one year of college. Inquiries and applications should be addressed to Dr. Richard G. Scobee, director of graduate training in ophthalmology, 640 South Kingshighway, St. Louis 10.

PERSONAL NEWS

Dr. James W. Smith Appointed Clinical Professor of Ophthalmology at New York University Post-Graduate Medical School.—Dr. James W. Smith has been appointed Clinical Professor of Ophthalmology at the New York University Post-Graduate Medical School of the New York University-Bellevue Medical Center.

SPECIAL NOTICE

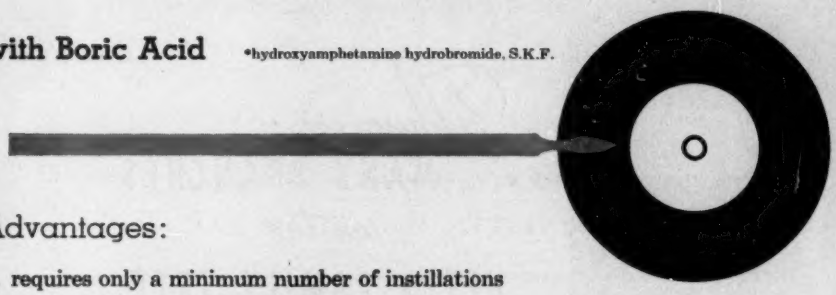
For the general information of indexers, catalogers and library personnel with reference to the listing of the new title of this journal, we advise that the *Quarterly Cumulative Index Medicus* policy be followed. The *Quarterly Cumulative Index Medicus* with its volume 49 (January-June 1951) will list this journal under the new title, so that the letters A. M. A. will be included as an integral part of the title. For the completion of volume 48 (July-December 1950) the *Quarterly Cumulative Index Medicus* will continue to use the old title, without adding the designation A. M. A.

How the 'Paredrine Technique'
in refraction saves the physician time and trouble

Ophthalmic Solution

Paredrine Hydrobromide* 1%

with Boric Acid *hydroxyamphetamine hydrobromide, S.K.F.

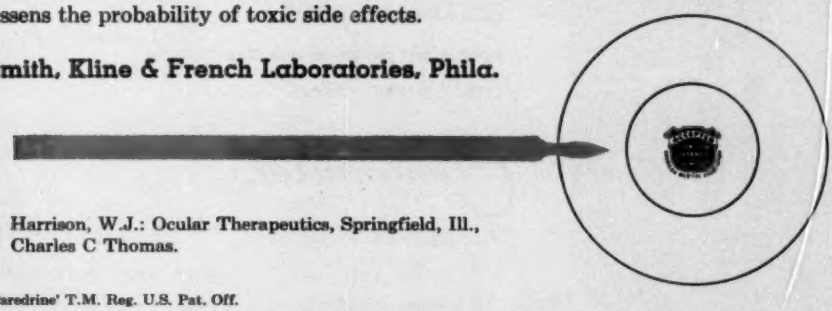


Advantages:

1. requires only a minimum number of instillations
2. helps achieve rapid cycloplegia
3. permits accurate refraction
4. assures a quick return of accommodation

The 'Paredrine Technique' in refraction saves the physician time and trouble and spares the patient prolonged visual disability. In the words of Harrison[1], it "has the advantage of maximum action with minimum duration." With children, the whole procedure can be carried out at the office; and the greatly reduced amount of atropine required for satisfactory cycloplegia lessens the probability of toxic side effects.

Smith, Kline & French Laboratories, Phila.



1. Harrison, W.J.: Ocular Therapeutics, Springfield, Ill., Charles C Thomas.

'Paredrine' T.M. Reg. U.S. Pat. Off.

There are
MANY BRANCHES
on the
ULTEX FAMILY TREE...

■ Complete and versatile, the Ultex line of Onepiece bifocals and trifocals offers the doctor the chance to pick and choose, the opportunity to prescribe just the right lens for the case.

All Ultex come from the same quality roots, all have the hereditary characteristics of ophthalmic precision and dependable optical performance.

Continental
INDIANAPOLIS

FOR THE BEST IN ARTIFICIAL EYES CONSULT

Well established firms who have specialized in eye making for generations.

THE FINEST IN GLASS OR PLASTIC EYES
ARE MADE AND FITTED BY

RICHARD DANZ & SONS
New York, New York

HUGO LEIPOLD
Pittsburgh, Pa.

EARLE C. SCHREIBER
Newark, New Jersey

G. DANZ & SONS
Los Angeles, Calif.
San Francisco, Calif.

GREINER & MUELLER
Chicago, Illinois

MAGER & GOUGELMAN, INC.
New York, New York

E & S DANZ
New York, New York

FRIED & KOHLER, INC.
New York, New York

MAGER & GOUGELMAN, INC.
Chicago, Illinois

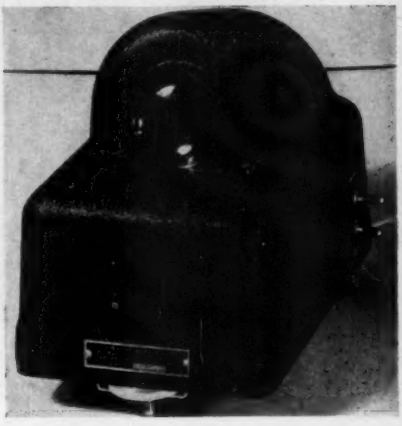
THE "AMIC" MACULA DEFICIENCY TESTER

developed by Dr. M. Goldschmidt,
formerly Professor of Ophthalmology, Leipzig University

An instrument to detect early abnormalities of the macula lutea—in a short routine check-up.

As a new instrument of diagnosis, it should belong to the standard equipment of every ophthalmologist.

Write for further information



AMERICAN MEASURING INSTRUMENTS CORPORATION
240 W. 40th St., New York 18, N. Y.

ALL **PLASTIC**

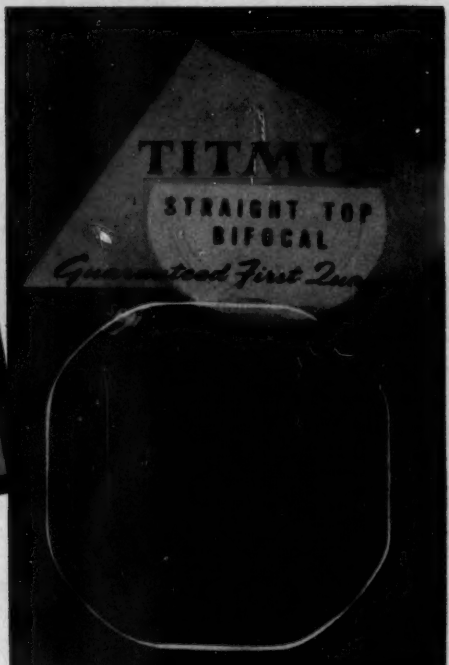
ARTIFICIAL EYES

Individually Created

DAVID A. GROSSBERG INC.
133 EAST 58th STREET NEW YORK 22, N. Y.
WICKERSHAM MEDICAL BLDG.

Introducing . . .

TITMUS Straight Top BIFOCALS



WITH BEST POSSIBLE DEFINITION FOR PATIENT COMFORT

- An exclusive Titmus achievement of manufacturing control provides uniform definition of bifocal segments. Further, all Titmus Straight Top Bifocals receive an extra inspection for additions and definition.

Now when you prescribe bifocals, specify Titmus Straight Top for uniform first quality and most assurance of patient satisfaction.

In White and Velvet Lite, A & B

- **55 x 60 mm.**
  Large enough for practically all modern frame shapes.
- **20 and 22 mm. SEGMENTS**
  In rights and lefts. Provide a wide angle reading field.
- **PITCH POLISHED**
- **BARIUM SEGMENTS**
  For greater freedom from color.
- **COMFORT DESIGN**
  Designed to place optical centers at natural visual position.

Titmus Optical Co., Inc.
PETERSBURG, VA.

SEX EDUCATION
BOOKLETS

● FOR YOUNG PEOPLE

Parents will find the help they are seeking in this modern series of pamphlets by Dr. Thurman B. Rice. Being a physician, biologist and teacher, as well as the father of a family, Dr. Rice is well equipped to deal with this difficult subject properly and helpfully.

THOSE FIRST SEX QUESTIONS
For the parents of very young children. Answers to the groping questions of the littlest ones. 40 pages. 25 cents.

THE STORY OF LIFE
For boys and girls ten years of age, telling them how the young come to plants and human parents. 36 pages. 25 cents

HOW LIFE GOES ON
For girls of high school age. Their role as mothers of tomorrow. 44 pages. 25 cents.

IN TRAINING
For boys of high school age, interpreting their adolescent development in terms of athletic and other achievements. 50 pages. 25 cents.

THE AGE OF ROMANCE
For young men and women, dealing with the problem as a unit for both sexes. 44 pages. 25 cents.

25c each
Set of five in file case, $1.00

● FOR ADULT READING

SEX EDUCATION FOR THE PRE-SCHOOL CHILD
By Harold E. Jones and Katherine Read. 12 pages. 15 cents.

SEX EDUCATION FOR THE TEN YEAR OLD
By Marjorie Bolles. 12 pages. 15 cents.

SEX EDUCATION FOR THE ADOLESCENT
By George W. Corner and Carney Landis. 20 pages. 15 cents.

THE FACTS ABOUT SEX
By Audrey McKeever. To be read by parents or children. 16 pages. 15 cents.

ANSWERS TO PRACTICAL QUESTIONS ON MENSTRUATION
By Margaret Bell. 8 pages. 10 cents.

SEX EDUCATION FOR THE MARRIED COUPLE
By Emily Hartshorne Mudd. 12 pages. 15 cents.

SEX EDUCATION FOR THE WOMAN AT MENOPAUSE
By Carl J. Hartman. 12 pages.
Set of 5 titles as above, 50 cents

GETTING READY FOR MARRIED LIFE
By Howard Dittrick. 29 pages. 20 cents.

HELP FOR CHILDLESS COUPLES
By J. D. Wassersug. 6 pages. 10 cents.

THE WORD YOU CAN'T SAY (MASTURBATION)
By Hannah Lees. 8 pages. 10 cents.

Quantity prices quoted on request

Also . . .

AMERICAN MEDICAL ASSOCIATION
535 North Dearborn Street
Chicago 10, Ill.

NOW- MORE ACCURATE VISUAL DIAGNOSIS IN THE EYE, EAR, NOSE AND THROAT

WITH THE NEW, IMPROVED

A.C.M.I. DIAGNOSTIC SETS

American Cystoscope Makers offers the medical profession the finest line of Diagnostic Sets in its entire history. These new sets incorporate the outstandingly important feature —exclusive with the ACMI ophthalmoscope—of a coated lens system, greatly increasing the amount of light transmitted, improving definition and clarity of the image, and eliminating halo, flare and ghost images.

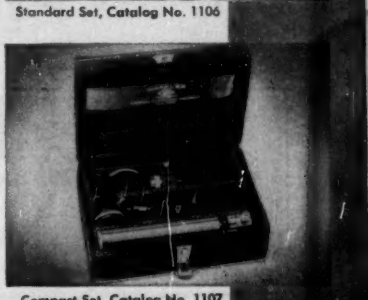
STANDARD SET comprises ophthalmoscope head (with built-in color filter and aperture changer), otoscope head with 3 specula, medium battery handle and one spare lamp, in plush-lined case, with space for additional specula and tongue depressor.

COMPACT SET, for the practicing physician, includes ophthalmoscope head (with built-in color filter and aperture changer), otoscope head, 5 ear and 1 nasal specula, small battery handle and extra lamp. Additional space for tongue depressor and more specula.

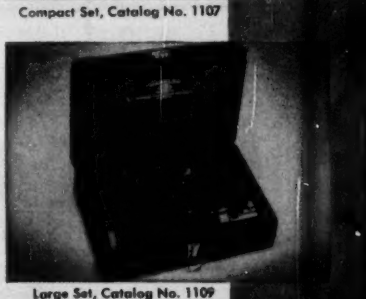
LARGE SET contains otoscope head, 5 ear and 1 nasal specula, ophthalmoscope head (with built-in color filter and aperture changer), large battery handle, 1 extra lamp, with provision in case for tongue depressor head, additional specula and lamp replacement.

PROFESSIONAL SET. This, the most complete Wappler set, incorporates an otoscope head with 5 ear and 1 nasal specula, tongue depressor head, ophthalmoscope head (with built-in color filter and aperture changer), large battery handle, extra lamp, and rubber bulb for insufflation.

Standard Set, Catalog No. 1106



Compact Set, Catalog No. 1107



Large Set, Catalog No. 1109

Professional Set, Catalog No. 1111

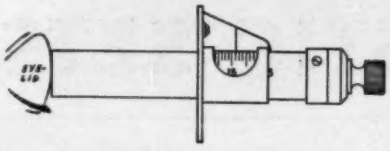
AMERICAN CYSTOSCOPE MAKERS, INC.

Frederick J. Wallace, President

1241 LAFAYETTE AVENUE • NEW YORK 59, N. Y.

NEW—

For Green's Refractor
The Phoro-Lenscorometer

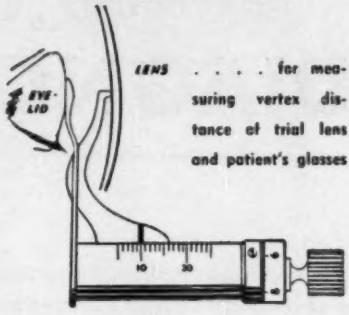


For use with *Green's Refractor* to measure vertex distance, just clear instrument of lenses, place Phoro-Lenscorometer through opening, making contact with patient's closed lid—and read *direct*. No computing necessary.

Each $12.75

For Trial Frame
The Lenscorometer

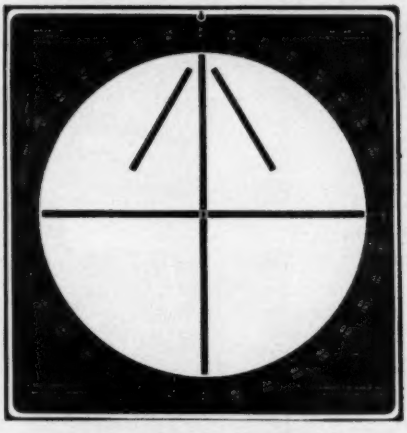
originated by Austin Belgard



LENS . . . . for measuring vertex distance of trial lens and patient's glasses

Use of Lenscorometer in all cases of aphakia, + OR — corrections of four diopters or more—a necessity to insure true translation of prescription.

Each $11.75



(Actual size 13½" x 14")

SIMPLIFIED ASTIGMOMETER

(Lebensohn)

PLASTIC

WASHABLE

"NO COMPUTATION REQUIRED"

Send for Literature

EACH $9.75

Austin Belgard INC.

OPHTHALMIC OPTICIANS

WHOLESALE & SERVICE

109 N. Wabash, at Washington (Formerly Belgard, Inc.) 9th Floor STate 2-5362

G-L Plastic
Artificial Eyes

High Pressure Molded
All-Plastic Irises
Anatomically Correct

Custom . . . Stock . . . Selections

Requests for literature and information are cordially invited.

Galeski Laboratory Inc.
737 East Main Street
Richmond 19, Virginia

Child Health

Bad Habits in Good Babies. Herman M. Jahr. 16 pages. 15 cents.

What Does Your Baby Put in His Mouth? Chevalier Jackson and Chevalier L. Jackson. Tells how to prevent accidents from choking and what to do if they happen. 24 pages. 10 cents

Keeping Your Baby Well. 22 pages. 10 cents.

The Case of the Crying Baby. Herman M. Jahr. 4 pages. 10 cents.

What to Do About Thumb Sucking. William I. Fishbein. 6 pages. 10 cents.

Lefthandedness. Paul Popenoe. 8 pages. 10 cents.

Adoption. W. Allison Davis and Theo Carlson. An understanding discussion of the best ways to adopt children and rear them. 12 pages. 15 cents.

Protecting Your Child from Allergy. William Gayle Roberts. 8 pages. 10 cents.

The Facts About Sex. Audrey McKeever. 16 pages. 15 cents.

Please remit with order

AMERICAN MEDICAL ASSOCIATION
535 N. Dearborn St. • Chicago 10

fitting without fuss

a new
DISPENSING CABINET

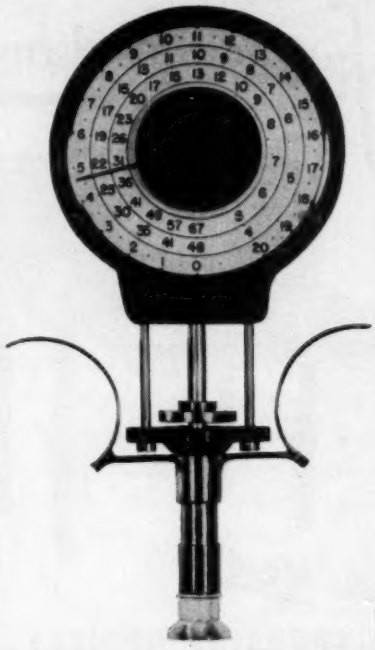
- STANDS ALONGSIDE FITTING TABLE OR EXAMINATION CHAIR
- HOLDS 120 FRAMES OR MOUNTINGS
- EACH FRAME STANDS ON ITS OWN RACK
- ELIMINATES DISORDERLY ARRAY OF SAMPLES
- OCCUPIES A MINIMUM AMOUNT OF SPACE
- AN IMPRESSIVE SAMPLE DISPLAY PLAINLY VISIBLE TO THE PATIENT

THE EFFICIENCY FITTING CABINET is 35" high, 25" wide, 18" deep, and is hand-rubbed to a beautiful walnut finish. With 4 drawers containing 30 mounts each, to hold any size zylonite or rimless frame, ample space is finally achieved for all needs.

69.50
F.O.B. N.Y.

ORDER DIRECT OR FROM YOUR SUPPLY HOUSE

OPTICAL CABINET CO.
BOX 673, BABYLON, N.Y.



The New

HARRINGTON TONOMETER

This is an extremely accurate instrument.

The dial has three scales, the outer being the expanded Schiotz scale, 0 to 20, the middle and inner scales being direct readings in millimeters of mercury for the 5.5 and 7.5 gram weights.

10 and 15 gram weights are included, with conversion table.

Descriptive leaflet sent on request.

Fully guaranteed

PARSONS OPTICAL LABORATORIES

518 Powell Street San Francisco 2, Calif.

GILL MEMORIAL EYE, EAR AND THROAT HOSPITAL

Announces to the Profession

TWENTY-FOURTH ANNUAL SPRING GRADUATE COURSE

in

Ophthalmology—Otology—Rhinology—Laryngology
Facio-Maxillary Surgery—Bronchoscopy
Esophagoscopy

GUEST FACULTY

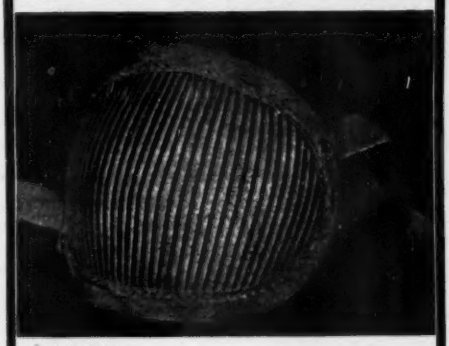
D. H. Anthony, M.D.	John R. Lindsay, M.D.
Maj. Gen. R. W. Bliss, M.D.	William P. McGuire, M.D.
Edwin N. Broyles, M.D.	C. Stewart Nash, M.D.
Edwin W. Burton, M.D.	R. Townley Paton, M.D.
J. Gordon Cole, M.D.	Lawrence Pool, M.D.
Jerry W. Conn, M.D.	A. D. Ruedemann, M.D.
John Converse, M.D.	Harold G. Scheie, M.D.
R. A. Cooke, M.D.	Robert H. Sinskey, M.D.
Arthur G. DeVoe, M.D.	Byron Smith, M.D.
Paul H. Holinger, M.D.	Joseph A. Sullivan, M.D.
R. W. Hollenhorst, M.D.	Harvey E. Thorpe, M.D.
Wendell L. Hughes, M.D.	Robert H. Trueman, M.D.

April 2 to 7, 1951

ROANOKE, VIRGINIA

For further information write:

Superintendent, Box 2467 Roanoke, Virginia



DOCTOR:

Don't give your patient an ordinary eye patch. Prescribe the

***"ADJUSTO"**

Eye Shield

AMBLYOPIA EXANOPSIA—Will not interfere with lid movement.

CORNEAL ULCER—Will admit air through shield.

INJURED OR POST-OPERATIVE CONDITION—Will do away with any unnecessary pressure.

The "ADJUSTO" is the only shield with a flexible frame that conforms to the facial contours, and expanding pleats adjustable to the eye dressing, without applying pressure. It is the only eye shield made which can be moulded around the lens of eye glasses with simple ease. The "ADJUSTO" can be boiled or autoclaved for sterilizing, or can be washed with soap and water and the pleats will not come out! Available at all leading Drug, Surgical and Optical stores. Retails at 50c.

ADJUSTO EYE SHIELD COMPANY

1060 Lexington Avenue, New York 21, New York

AS NEW AS THE

New Year

Soft-Lite HT·51

the first genuine Soft-Lite glass . . .
developed specifically for heat-treating!

Research cannot be denied! For almost a decade the men who delve into the mysteries of glass at Bausch & Lomb have worked to perfect a Soft-Lite glass with exclusive heat-treating properties. Now it's ready . . . under the formula designation "HT-51".

Now, your patients requiring the neutral absorption qualities of Soft-Lite can enjoy the additional advantage of breakage-resistant HT-51 glass for industrial safety or ophthalmic heat-treated lenses.

Only Soft-Lite HT-51 offers you...
...the same neutral, natural transmission as regular Soft-Lite.
...the same good looking flesh tone as regular Soft-Lite.
...the same Comparator identification as regular Soft-Lite.

Yes, Soft-Lite HT-51 glass is as new as the New Year itself! Your friendly Soft-Lite supply house with a hardening furnace can fill your Rx's for heat-treated Soft-Lite HT-51, as well as Soft-Lite for regular wear.

Soft-Lite Lenses

Internationally prescribed for light-sensitive eyes

Thank You Doctor
for Prescribing
Obrig Superior Quality
Contact Lenses

Obrig Laboratories Inc.
49 EAST 51st STREET • NEW YORK, 22, N. Y.

Branches in
PHILADELPHIA MONTREAL LONDON
JOHANNESBURG SHANGHAI

Obrig

PAMPHLETS ABOUT **Vision**

Whom Shall I Consult About My Eyes? F. T. Jung. 8 pages. 10 cents.

Eyes—Right! Audrey McKeever. 14 pages. 15 cents.

How to Save Your Eyes. Cleo Du Bois. 4 pages. 10 cents.

Should Your Child Wear Glasses? J. Robert Burke. 12 pages. 15 cents.

Color Blindness. Dean Farnsworth and Conrad Berens. 2 pages. 10 cents.

New Eyes for Old (Corneal Transplant). Max Fine. 10 pages. 20 cents.

Glaucoma. Arthur A. Knapp. 12 pages. 15 cents.

Cataract. Abram B. Bruner. 12 pages. 15 cents.

Visual Efficiency. Henry A. Imus. 8 pages. 10 cents.

Please remit with order

AMERICAN MEDICAL ASSN.
535 N. Dearborn St. • Chicago 10

POSTGRADUATE CONFERENCE IN NEUROMUSCULAR ANOMALIES OF THE EYES

The Children's Memorial Hospital, Chicago
By George P. Guibor
For Graduates in Medicine April 8-13, inclusive, 1951

Course Includes Theoretical and Practical Surgical and Non-Surgical Examinations and Treatments

1. Anatomy
2. Physiology
3. Discussion of Patients with Squint
4. Examination of Patients by Students

Fee $75.00

For Further Details Apply to the Secretary of Course
The Children's Memorial Hospital, 707 Fullerton Avenue, Chicago 14

BERENS PRISM BARS

FOR

COMPLETE PRISM EXAMINATION OF ALL FORMS OF

MUSCULAR UNBALANCE AND ORTHOPTIC TRAINING

NO. B-14

Horizontal Bases

for

Base Up or Base Down

No. B-10 Exercise Bar

Prism Diopters—½-1

1½-2-3-4-5-6-8-10

Price $15.00

No. B-14 For Home or Office Use

Prism Diopters—1-2-3 4-5-6-8-10-12-14-16-18-20-25

Price $25.00

Vertical Bases

for

Base In or Base Out

No. B-5 Pocket Bar for Home Exercise

Prism Diopters—3-5-10-15-20

Price $10.00

No. B-15 For Home or Office Use and Screen Test

Prism Diopters—1-2-4-6-8-10-12-14-16-18-20-25-30-35-40

Price $25.00

NO. B-15

AVAILABLE AT YOUR SUPPLIER

MANUFACTURED BY

4920 N. LAWRENCE ST. **R. O. GULDEN** PHILADELPHIA 20, PA.

Follow Current Developments in Pediatrics with the A. M. A. American Journal of DISEASES of CHILDREN

Significant contributions, amply illustrated.

Today's practice and opinion among notable workers in pediatrics.

Brilliant editorial leadership: CLIFFORD G. GRULEE, *Chief Editor*, Evanston, Ill.

H. F. HELMHOLZ, Rochester, Minn.

OSCAR M. SCHLOSS, New York

FRANCIS SCOTT SMYTH, San Francisco

ROBERT B. LAWSON, Winston-Salem, N. C.

A. A. WEECH, Cincinnati

JAMES L. WILSON, Ann Arbor, Michigan

AMERICAN MEDICAL ASSOCIATION

535 N. Dearborn St., Chicago 10, Illinois

Please Begin My Subscription to A. M. A. American Journal of DISEASES of CHILDREN with the Next Issue.

.....M.D.

.....STREET

.....CITY & STATE

$12.00 YEARLY

$13.50 FOREIGN $12.40 CANADIAN

AND NOW THROUGH

A New Grip on Problems of Industrial Medicine

A Journal Designed For Your Interests

ARCHIVES of INDUSTRIAL HYGIENE and OCCUPATIONAL MEDICINE

Edited by: Men of outstanding reputation in the fields of industrial health and preventive industrial hygiene.

Prof. Philip Drinker, Boston, Chief Editor
Robert Kehoe, M.D., Cincinnati; James Sterner, M.D., Rochester, N. Y.; Frank Patty, Detroit, Mich.; Theodore Hatch, Pittsburgh; Frank Princi, M.D., Denver; Fenn E. Poole, M.D., Glendale, Calif.; William A. Sawyer, Rochester, N. Y.

Covering the RESEARCH AND FIELD ASPECTS of industrial hygiene and the CLINICAL AND MEDICAL ASPECTS of occupational industrial health programs.

Merging the best features of Occupational Medicine and The Journal of Industrial Hygiene and Toxicology.

Integrated closely with the activities of the Council of Industrial Health of the A. M. A. and the American Industrial Hygiene Association.

A BETTER AND MORE USEFUL JOURNAL of industrial medicine! Such is the result which the Editorial Board of ARCHIVES of INDUSTRIAL HYGIENE and OCCUPATIONAL MEDICINE has achieved by combining parallel publications.

To the thousands of physicians who are directly or indirectly concerned today with medicine in industry, the new journal will bring reports of the continuing and important developments in the field, with original articles covering problems and day to day experiences of physicians in industry; an excellent abstracting service similar to that carried in the Journal of Industrial Hygiene and Toxicology; additional foreign journal abstracting; reviews.

Whether servicing industrial firms, attending employees, applying to general practice some of the findings of industrial medicine, or merely *watching* this expanding field, you will want to receive this vital new periodical *from the first issue.*

AMERICAN MEDICAL ASSOCIATION
535 N. Dearborn, Chicago 10

Enter my subscription to ARCHIVES of INDUSTRIAL HYGIENE and OCCUPATIONAL MEDICINE to start *with the next issue.* Per year, $8.00 in U. S. (Canadian, $8.40; Foreign, $9.00).

I enclose check..... Please bill me.....

Name..... Address.....

.....

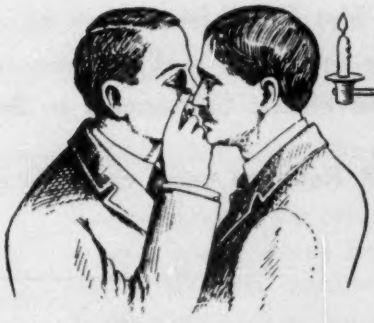
WELCH ALLYN *joins in celebrating*

THE 100th ANNIVERSARY

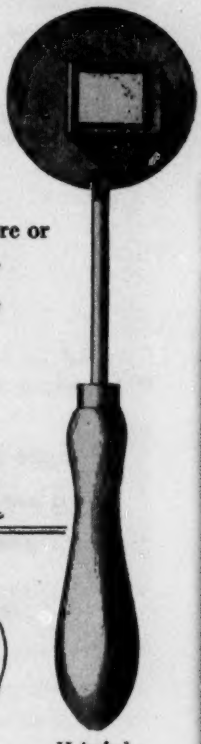
of the invention of the Ophthalmoscope

On the centennial of the invention of the ophthalmoscope by Helmholtz in 1851, it seems fitting that we at Welch Allyn should salute his memory. Thirty-seven years ago Welch Allyn made one of the first American electric ophthalmoscopes, and today our craftsmen produce more of these instruments than any other company, here or abroad. Yet the basic principles of our modern ophthalmoscope are still those developed by Helmholtz's genius 100 years ago.

Welch Allyn Ophthalmoscope 1951



Reproduced from an early drawing showing the ophthalmoscope in use.

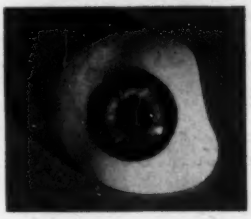


Helmholtz Ophthalmoscope 1851

WELCH ALLYN, INC. Auburn, N.Y.

Electrically Illuminated Diagnostic Instruments

FRIED & KOHLER'S



so "TRUE TO LIFE"

PLASTIC AND GLASS

ARTIFICIAL HUMAN EYES EXCLUSIVELY

Made in Our Own Laboratory

- **Comfort and Pleasing Cosmetic Appearance Guaranteed.**
- **Eyes also fitted from stock by experts. Plastic or glass selections sent on memorandum. Implants and Plastic Conformers in Stock.**
- **Referred cases carefully attended.**

FRIED & KOHLER, INC.

665 FIFTH AVE. (near 53rd St.) NEW YORK 22, N. Y. Tel. ELdorado 5-1970

"Over Fifty Years devoted to pleasing particular people."

Position's everything in life...

. . . and in Fitting Trifocals

The method of prescribing and fitting AO Tillyer Ful-Vue Trifocals is, of course, a matter of professional choice. However, the use of an intermediate segment raises the question of its position in the lens relative to the near segment and the patient's line of sight.

Among practitioners, there are two major schools of thought on this subject:

1. Fit reading segment exactly as in fitting a bifocal, letting this determine the position of the intermediate segment.

2. Fit reading segment approximately 2 mm. lower than normal, thus freeing the pupil area of any possible reflection.

Your nearest AO Rx Laboratory can supply you with AO Tillyer Ful-Vue Trifocal Lenses in White, Cruxite A, and Cruxite AX. On special order, they may be obtained in Cruxite B, C, D and Calobar B, C, D.

For those who prefer other types, AO Trifocal Lenses are available in Tillyer Panoptik, Tillyer "A", Tillyer "B", and Tillyer "E". Intermediate segment in Panoptik is 66% of addition. Others are available in any prescribed strength for intermediate.

Many authorities use both these methods —basing their choice on the patient's individual tolerances, characteristics, and activities. Whichever method is used, fitting trifocals presents no insurmountable problem. And the prescribed benefits of AO Tillyer Ful-Vue Trifocals will bring real patient satisfaction to those presbyopes, in all walks of life, requiring a 1.75 D. add, or more.

American Optical
COMPANY

NEO-SYNEPHRINE OPHTHALMIC

Neo-Synephrine hydrochloride, a well tolerated, reliable vasoconstrictor and mydriatic, is available in various concentrations and several forms for a variety of ophthalmic indications.

Congestive conjunctivitis: **1/5% solution.**
For rapid relief of itching, smarting and excessive tearing due to physical or chemical irritants or allergy.

Refraction, funduscopic examination: **2.5% solution and 1% emulsion.**
For prompt and short acting mydriasis virtually free from cycloplegia.

Preoperative Use: **2.5% solution and 10% solution.**
For short acting powerful mydriatic effect, applied 30 to 60 minutes before surgery.

Uveitis, posterior synechiae: **10% solution and 10% emulsion.**
For freeing recently formed posterior synechiae as well as for prevention of synechiae formation in uveitis (with atropine).

Glaucoma (certain cases and tests): **10% solution, 10% emulsion and 2.5% solution.**
For the provocative test for angle block as well as for the shadow test.

NEO-SYNEPHRINE®
HYDROCHLORIDE
Brand of
Phenylephrine hydrochloride

Winthrop-Stearns INC.
New York 13, N. Y. Windsor, Ont.